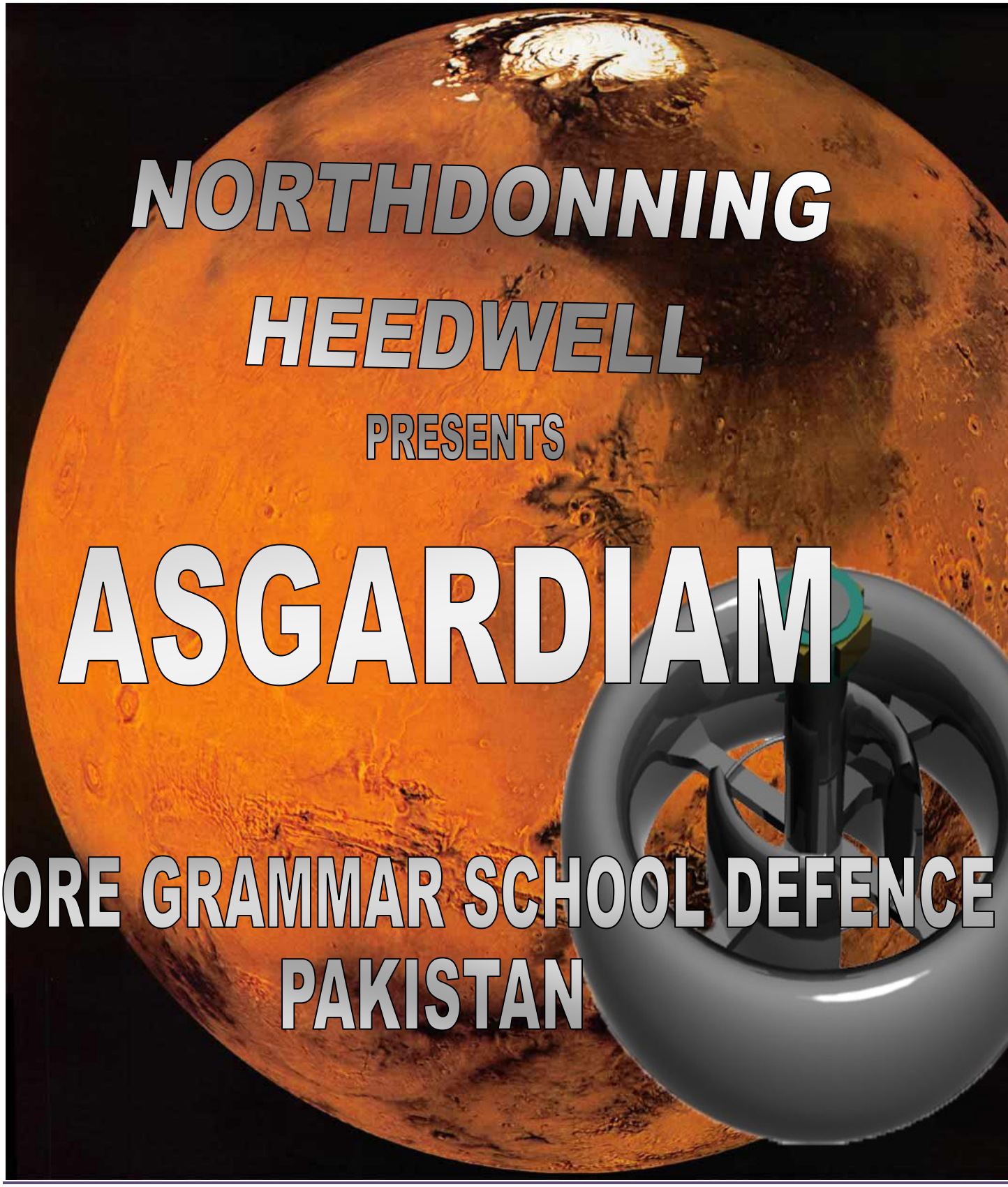
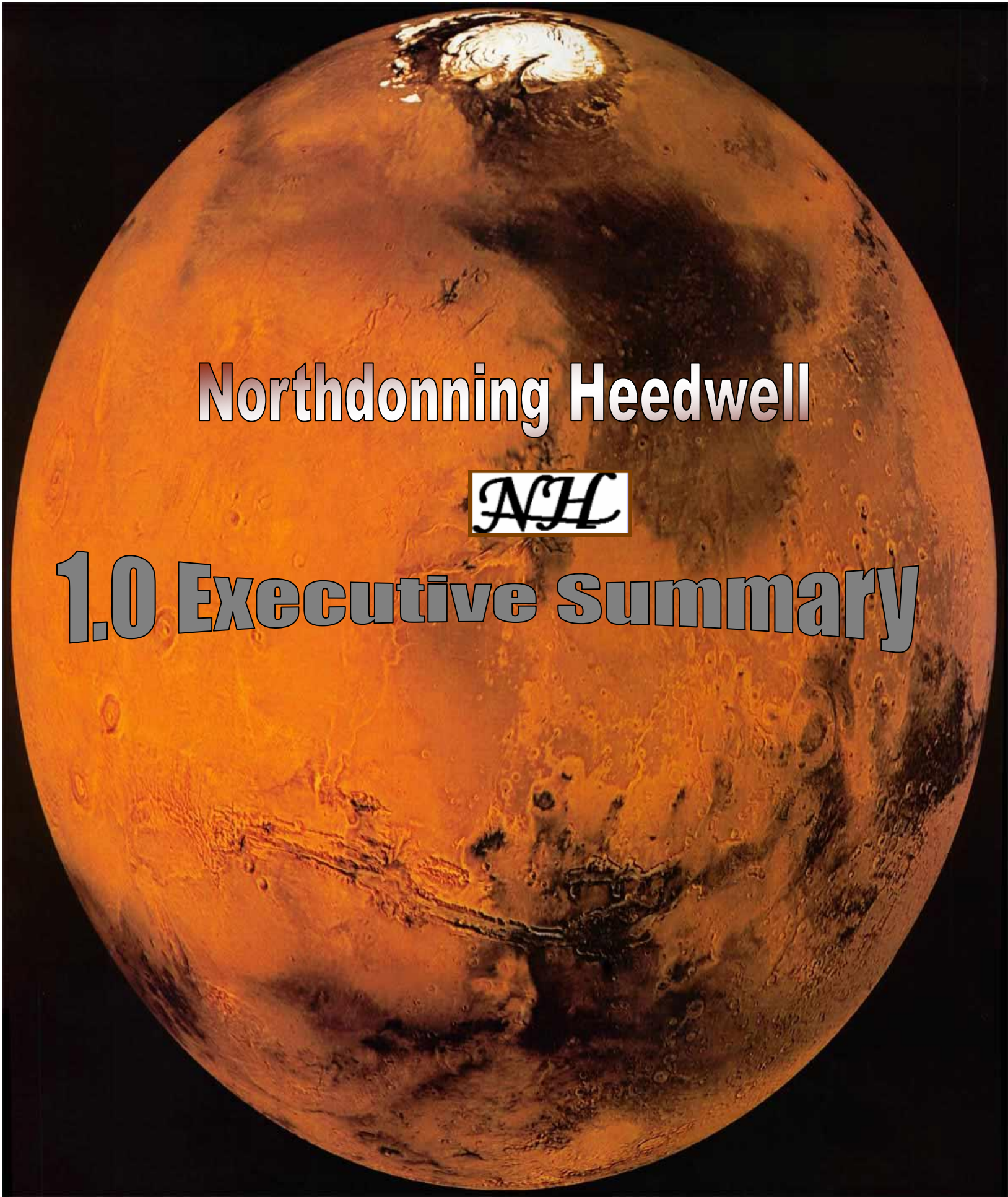

NORTHDONNING
HEEDWELL
PRESENTS
ASGARDIAM
LAHORE GRAMMAR SCHOOL DEFENCE
PAKISTAN



Northdonning Heedwell

1.0 Executive Summary

1.0 EXECUTIVE SUMMARY

In response to the Foundation Society's request for proposal, dated 3 January 2055, are pleased to present to you Asgardiam, a gateway to Mars, forming the much awaited bridge between Earth and Mars.

Asgardiam has an inclination of 0 degrees with respect to Mars equator and is at an altitude of 17053 km from the surface of Mars.

After a detailed analysis of the requirements of the Foundation Society, Northdonning Heedwell has proposed a structure for Asgardiam that not only provides stability but also Earth-like living conditions such as 1g for human dwelling which would help humans adjust to the environment of the settlement with least difficulty. The structure constitutes of one complete modified torus and one segmented torus of smaller radius. It has a docking port for incoming and outgoing passenger and cargo ships which will generate revenue. Also, large research area has been provided for, which aids speedy exploration of Mars and at the same time contributes to business development. The structure has the capability to expand for an increase in population, as well as to isolate its parts in case of emergencies.

Date the contract was awarded	7 May 2055
Date of completion	6 May 2073
Total population	20,000 + transient population of 500
Total cost	**$487,473,026,500**

The settlement has been kept in between Phobos and Deimos, where the two mining bases will be established to harvest resource materials. The refining of materials will also be done on Phobos and Deimos. This will help in the proficient construction of our settlement. The atmosphere has been kept close to the Earth environment in order to sustain life. Asgardiam will have a very efficient transport and communication system to enable the residents to live a convenient life. The entire necessary infrastructure like water management and waste management has also been installed. Exterior and interior construction machinery like the assembly machine and springer has been designed.

Northdonning Heedwell has made Asgardiam an efficient working place which is secure, healthy and comfortable for the people who will work in this settlement. Since it is a large habitation and far away from the earth, Northdonning Heedwell aims to provide an environment as similar to earth as possible. It will provide the citizens with the best amenities and resources. Along with superior quality, a sufficient quantity of consumer goods will be provided. World class leisure activities, long lines of sights and natural sunlight will give the residents a feeling of homeliness. The settlement has been divided into 2 torii. The inner segmented torus contains agricultural area and research area. Artificial gravity has been provided so that psychological and physiological problems are kept to a minimum. Earth like day and night cycle has been adopted to ensure that the residents live healthily and happily.

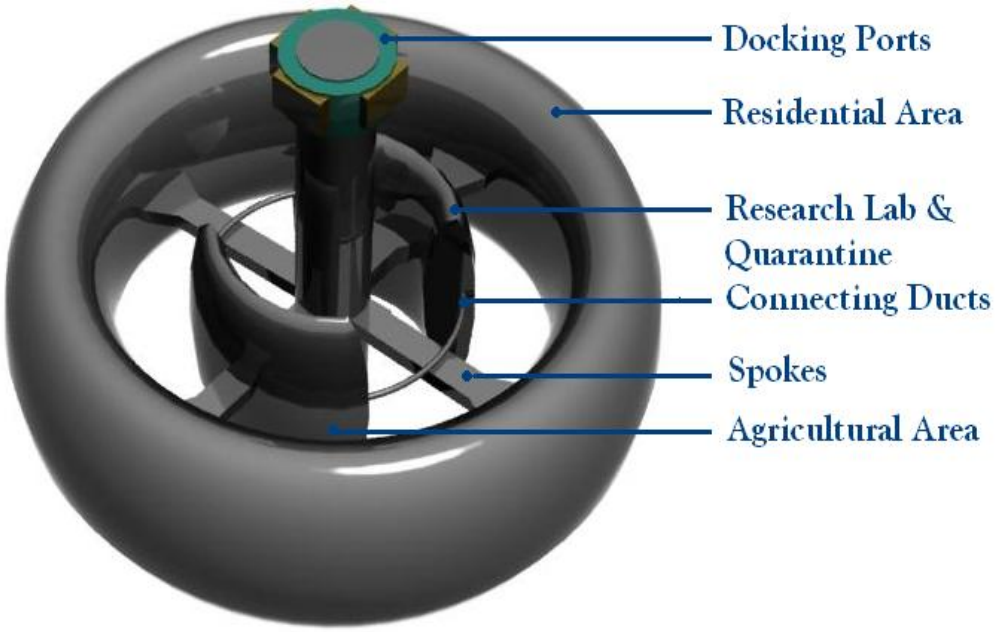
Automation is a pre requisite for the success and survival of every space settlement. From construction to generating profits for the sustenance of the settlement, automation is used every where aboard Asgardiam. Northdonning Heedwell proudly boasts of one of the best automated systems in the aerospace industry. Asgardiam will make use of virtual server, swift networking, invincible security, fully automated robots and an inevitable backup system, for we at Northdonning Heedwell put nothing before the comfort and safety of our customers.

"People see things as they are and ask why. We build things as they never were and ask why not."

2.0 STRUCTURAL DESIGN

2.0 STRUCTURAL DESIGN

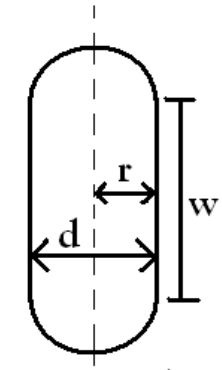
2.1 Exterior Configuration:-



The residential, agricultural and research sectors are special kind of torii. They have flattened walls as seen from the diagram. The purpose is to reduce the amount of atmosphere that is filled inside the settlement as well as the materials needed to level the torus-floor to form an even down surface.

The agricultural and research torii are segmented so that they provide for exact amount of space needed and also if need be, both these segments could expand to form one single torus.

Further, the connecting ducts play a special role. Due to the settlement's rotation and inertia of the air, the air accumulates at one end and forms high atmospheric density at one end of each segment. These connecting ducts prevent such air accumulation. Further each duct is equipped with an elevator and supply lines to ease the transportation of people, robots and materials between the two segments.All parts of the settlement are rotating except for the docking ports present at both ends of the central cylinder.



cross-section of the torus

2.1.1 Dimensions of Major Hull Components:-

Rotation Rate = 0.98 rpm							
Hull Component	Major Radius /R (m)	Minor Radius /r (m)	Floor Width /w (m)	Vertical Clearance /d (m)	Down Surface Area (m^2)	Total Surface Area (m^2)	Artificial g. (m/s^2)
Central Hub	40	-	-	80	-	85.45×10^3	0.42
Agricultural Segment	465.5	32.5	641.3	65	625250	1.45×10^6	4.903
Research Labs & quarantine segment	465.5	32.5	641.3	65	625250	1.45×10^6	4.903
Residential sector	931.5	35	329.8	70	1930075	5.147×10^6	9.81
Spokes	931.5	20	-	40	-	0.117×10^6 per spoke	-

2.1.2 Uses of large enclosed volumes:-

Hull Component	Pressurized/Rotating	Uses
Central Hub	Non-pressurized, rotating except for the docking ports	Control unit, storage facilities, Industries, docking ports with capability to expand
Agricultural Segment	Pressurized; rotating	Animal husbandry, crop cultivation, processing, packaging and distribution centre of food products
Research Labs & quarantine segment	Pressurized; rotating	research labs, observatory, quarantine and storage
Residential sector	Pressurized; rotating	Residential, commercial uses, graveyard, etc.
Spokes	Non-pressurized; rotating	For transportation

Industries are located in a near zero-g area so that machines work more efficiently. Secondly, they are very near to the docking ports hence, transportation costs are reduced. Research labs have been given a large area along with quarantine facilities so that hazardous products maybe isolated and new products from Mars that have commercial potential maybe recognized.

2.1.3 Construction Materials:-

The outermost layer is a mixture of Martian regolith and water. Then follow layers of Kevlar and Nextel. Beneath that is a mesh of carbon nanotubes, to provide structural support. Super Adobe makes the fourth layer. After that framework construction layers are laid with layers of Alvoelux and RXF1 sandwiched in between them to absorb the secondary radiations. The inner-most layer would be that of Invar. RTV Adhesives would be used to bind different layers together. Lead Glass would make the outermost layer of the transparent parts of the settlements such as windows, etc. Their innermost layer would be made of Silica Aerogel.

Framework Construction Materials			
	Materials	**Properties and use**	**Source**
1.	**Aluminum Silicate**	Low density; Used in the inner walls (internal construction material); high thermal shock resistance as it has a high melting point; transparent material	Soil from Phobos and Deimos
2.	**Invar (Nickel-iron composite)**	Invar is a 36% nickel-iron alloy which has the lowest thermal expansion among all metals and alloys in the range from room temperature up to approximately 230°C. The alloy is ductile and easily weld able. It does not suffer from stress corrosion cracking. Secondary construction material	Refining soil from Phobos and Deimos
3.	**RTV Adhesives**	Wide operating temperature range -115 to 300ºC; Excellent electrical properties; Flexibility; UV rays resistant; Good chemical resistance; No or low toxicity; excellent for binding layers together.	Processing soil from Phobos and Deimos
5.	**Silicate raw material**	Construction of solar panels and also to manufacture glass	Soil from Phobos and Deimos

6.	**Aluminum Oxynitride**	Very light; excellent electrical insulator; transparent with glossy, scratch-resistant surface; durable	Earth

2.1.4 Means of protecting and debris penetration:

The settlement is susceptible to fast moving meteorites and debris. Therefore the layers of the settlement should be resistant enough to stop the debris penetration. Also, the presence of space radiations such as solar flares, cosmic rays and ionizing radiations like X- and gamma rays means that the outer layers of the settlement should have thermal stability to provide necessary shielding.

In case of a puncture in the wall, the hole would have to be quickly sealed by the robots. To prevent the loss of too much air before robots arrive, there is a makeshift measure that would seal off the wall temporarily. This includes the presence of a non-Newtonian fluid sandwiched between the layers and contained inside relatively thin membrane. When the wall is punctured, the pressure inside the settlement would cause the membrane to rupture and the fluid rises. As it comes out, it freezes and thus acts as a plug.

Debris and Radiation Protection		
Materials	**Properties and its Use**	**Source**
Super Adobe	Sandbags and barbed wire technology; Good insulator, absorbs radiations	Mars Regolith
Silica Aerogel	Absorbs infra-red radiation; Can absorb kinetic energy; can be recycled and is completely non-toxic and inflammable; transparent material, can also be used to construct windows	Earth
Regolith + Water	The metals in the regolith, like that of Martian soil can block ionizing particles; can absorb radiations	Martian soil
RXF1	polyethylene-based material; stronger and lighter than aluminum; 50% better at shielding solar flares and 15% better for cosmic rays than Al; they produce far less "secondary radiation" than heavier materials like aluminum or lead	Refining organic matter available at Phobos and Deimos
Nextel	Made from aluminum oxides and silicates ;protects from debris due to its high tensile strength; Stronger than aluminum, fireproof and able to withstand meteoroids;	Refining silicates and aluminum oxides in soil available at Phobos and Deimos
Kevlar-49	Impact-resistant outer tiles made from organic fiber; Debris protection due to high tensile strength; used in the form of tiles to protect against high velocity particles; resistant to high temperatures	Refining organic matter available at Phobos and Deimos
Carbon nanotubes	Provides structural support as well as protection against particles that penetrate Kevlar tiles;	Raw materials could be obtained from asteroids.

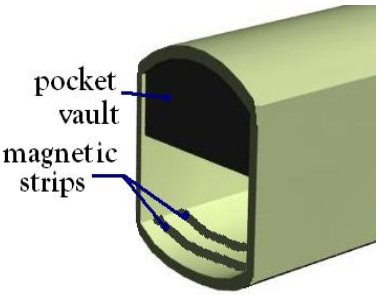
2.1.5 Rationale for rpm and artificial gravity:-

The rotation rate selected is 0.98 rpm which is less than 1 and hence prevents dizziness disorders/ motion sickness, nausea and possibly mental sickness in animals and humans due to Coriolis Effect. Artificial gravity is supplied by rotating the settlement with the rpm 0.98. The rotation is carried out by Hall Electric Propulsion System attached to the central cylinder.

Hull Component	Artificial gravity m/s^2	Justification
Central Cylinder	0.42	Low g allows for high efficiency of machines present in the industrial area, Docking ports operate best at zero gravity and storage is easy
Agricultural Segment	4.903	Allows for optimal growth of plants.
Research Labs	4.903	Provides enough g for the experiments and research to be carried out; the molecular behaviour, biochemical separations, crystallization, etc are more enhanced at micro-g
Residential Sector	9.81	best suited for human dwelling, psychologically viable and increases human efficiency

2.1.6 Isolation Technique:-

To isolate parts of our settlement, the residential sector would be separated into 6 sections and the central cylinder is divided into half. The agricultural and the research lab segments form two separate volumes. The sections are equally spaced in the residential sector. At the ends of each section are **pocket vaults** erected from the roof of the torus. To the residents they would seem to be coming out from a side wall. Each pocket vault would cover nearly half of the cross-sectional area of the torus. Two sections are separated by two pocket vaults, next to each other. These vaults would contain shutters/doors of the size that they could completely fit the uncovered cross-sectional area when released. These shutters would have a **layer of Ferro-magnetic substance** at their lower edges. The area directly beneath the two pocket vaults would also be covered with two **strips of electromagnets**, so that when the two shutters fall, they lie exactly on these strips. In between these pocket vaults are **vacuum pumps** put up on the walls of the torus. At the side of each pocket vault, would run **green and red lights**.



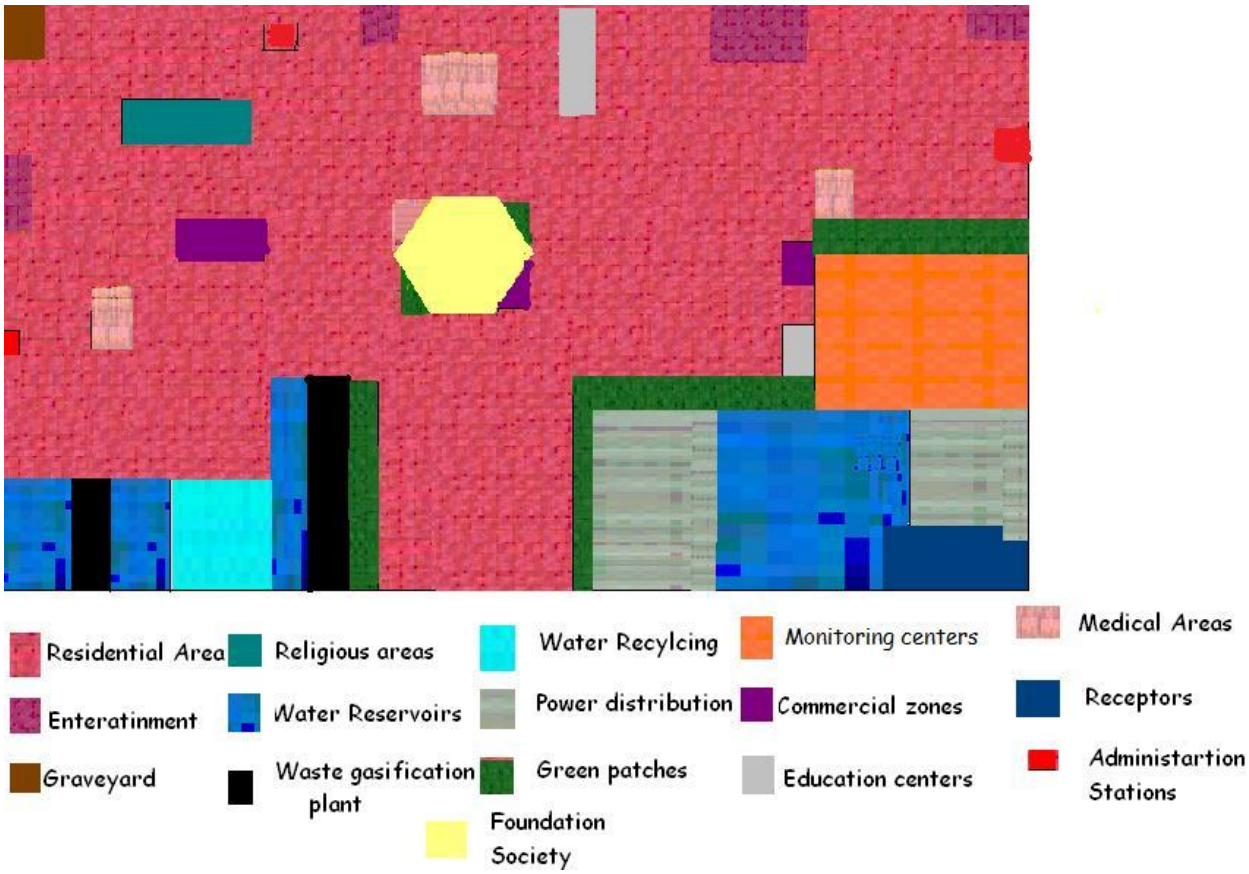
In case of an emergency, the residents would have to quickly evacuate the affected area. In the affected area, red light would be turned on, whereas in the adjacent safer sections of the torii, the green lights would be activated. This would help the residents to figure out their way to safer areas. For residents too far away from the exits, **emergency mobiles** would carry them to the safer sections. As soon as the people evacuate, that section would be sealed off. For that, the shutters are released and the strips on the floor are magnetized. As the shutters fall, their lower edges are magnetically attracted by the strips so they would shut tightly, sealing the area completely. Also, the vacuum pumps are activated, which pump air out of the tiny space between these vaults, so that if there is a toxic gas in a section it couldn't move to the next due to the presence of vacuum between the two shutters.

2.2 Internal Arrangement:-

2.2.1 Percentage Allocation Residential Sector	Area(m^2)	%age area
Residential Area	795143.75	41
Entertainment	127223	6.6
Museum		
Parks		
Hotels and Restaurants		
Sports complex, gymnasium etc.		
Spas and clubs		
Miscellaneous		
Medical area	63611.5	3.3
Hospital		
Clinics and other centers		
Roads and pathways	134931.625	7.00
Water Recycling plant and reservoirs	339787.5	17.6
Administration stations	31805.75	1.65
Fire Department		
Police Stations		
Miscellaneous		
Foundation Society Headquarters	35902.875	1.86
Graveyard	35902.875	1.86
Educational centers	31805.75	1.65
Green open spaces	47708.625	2.5
Monitoring centers	95417.25	4.94
Commercial Zones	63611.5	3.3
Businesses		
Banks		
Shopping Malls		
Religious places	63611.5	3.3
Waste gasification plants	63611.5	3.3

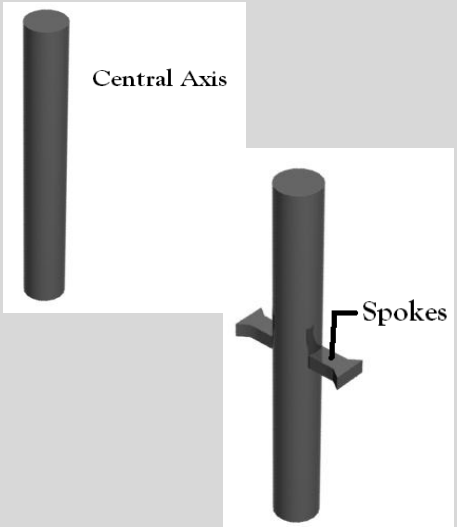
Agriculture	Area(m^2)	%age area
Plant growing area	468937.5	75
Animal breeding area	31262.5	5
Warehouses	31262.5	5
Agricultural drying units	31262.5	5
Water plant	31262.5	5
Roads and pathways	31262.5	5
Research	Area (m^2)	
Laboratories	43167.5	6.9
Training centers	31262.5	5
Water plant	46893.75	75
Emergency and repair centers	15631.25	
Storage area	31262.5	5
Roads and pathways	31262.5	5
Temporary residence	31262.5	5

2.2.2 Orientation of Down Surface Area:-

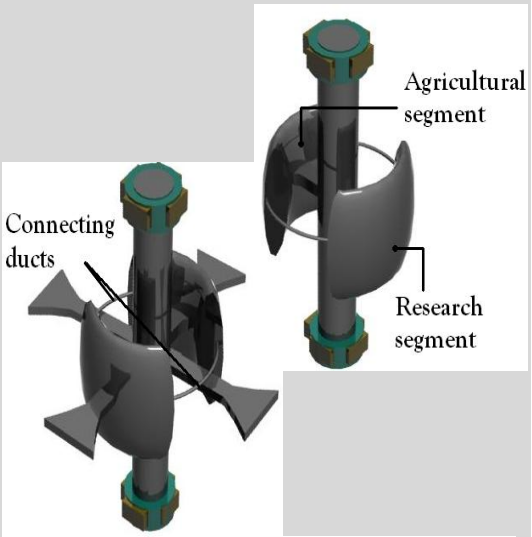


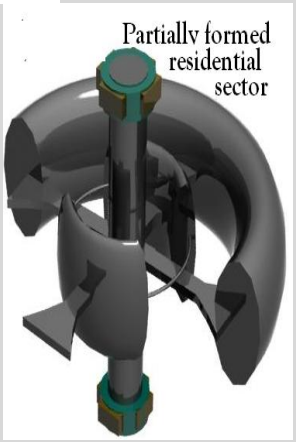
2.3 Construction Sequence:-

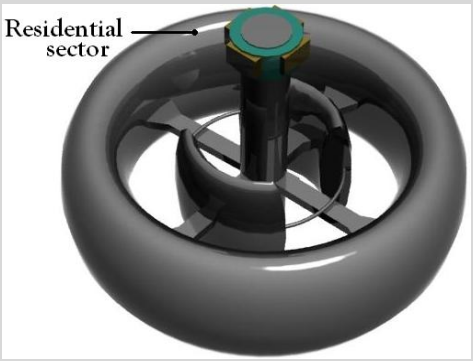
2.3.1 Construction Process:

Phase	Process	Diagrams
Phase 1	This phase shall initiate the joining of pre-built cylindrical sections which will be assembled on site to form the central hub. Small blocks made from Invar shall be welded to make layer upon layer to give the final shape of a cylinder.	
Phase 2	In this phase, two spokes are made to protrude from the centre of the cylinder. During this time, the control unit shall be set up in the central hub.	
Phase 3	Docks shall then be constructed around both ends of the cylinder. Floating solar panels shall be the source for interim power generation facility, consisting of two floating solar panels that supply adequate power to the spaceport and control unit	
Phase 4	Small rings shall then be welded to form two segments of a torus which	

	shall be framed around the existing spokes.
Phase 5	Next, four spokes shall be extended, two from the segmented torii, and two from the central portion of the cylinder. On total completion of each sector, the sector is shut off and sealed, until completion.
Phase 6	Similar in its construction process to phase 3, a segment of a torus shall be subtended from the hub with an angle of 180^{o} and shall then be sealed.
Phase 7	This phase shall initiate the completion of the outer torus by opening the seal and constructing the other half. Polaroid sheets are laid sandwiched between the outer layers of its wall.
Phase 8	We set up a solar satellite at Mars L1 point. After that, receptors (rectennas) are installed inside the settlement, in the residential sector which convert the microwaves into electricity.
Phase 9	Pressurized air shall now be released into the settlement and communication facilities shall be provided.
Phase 10	Hall Electric Propulsion System shall now equip the settlement which shall be turned on to finally give the settlement its rotation.







2.3.2 Construction Technique:

Using materials from Phobos and Deimos we have following construction techniques.

1. Electron beam freeform fabrication (EBF^3):

- The basic 3D design is fed to the computer for producing structural metal parts
- Can change chemistry, can change micro structures and incorporate things like sensors in to the parts as they are being built

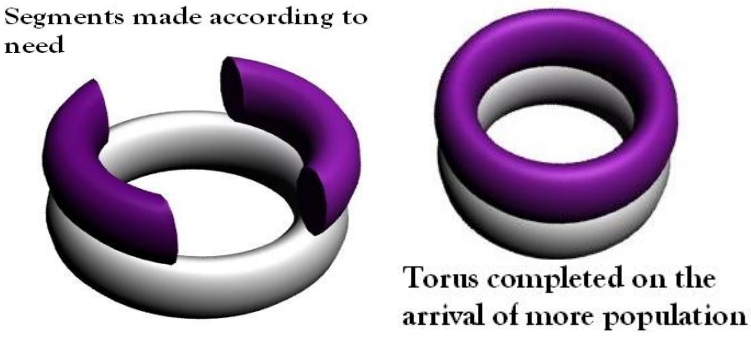
- Could provide a way for astronauts to fabricate structural spare parts and new tools aboard the International Space Station or on the surface of the moon or Mars.
- Uses a focused electron beam in a vacuum environment to create a molten pool on a metallic substrate
- Layer-additive process enables fabrication of structures from a solid wire feedstock.

2. Laminated object manufacturing:
In it, layers of adhesive-coated metal laminates obtained from refining the soil of Phobos/Deimos are successively glued together and cut to shape with a knife or laser cutter. The basic 3D design is fed to the computer. The process is performed as follows:

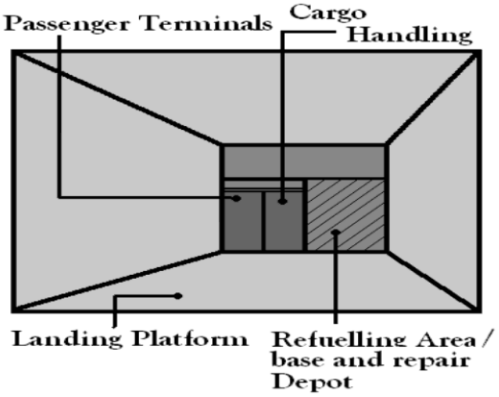
- Metal sheet is adhered to a substrate with a heated roller.
- Laser traces desired dimensions of prototype.
- Laser cross hatches non-part area to facilitate waste removal.
- Platform with completed layer moves down out of the way.
- Fresh sheet of metal is rolled into position.
- Platform moves up into position to receive next layer.
- The process is repeated.

2.4 Expansion

To accommodate the growing population, there are few expansion techniques.



1. The residential torus could expand itself to form a banded torus. When the need arises, another torus is created above the existing one, segment-by-segment, and the wall between the two torii is then eliminated, resulting in an increased floor width.
2. The agricultural segment and research segments maybe expanded, to form a complete torus. However, there would not be much need of expansion in both these segments especially in case of agricultural segment, crops are stacked vertically.
3. If the size of the spacecraft is larger than the standard size, the information would be fed to the computers. There are landing platforms which can be extended out with the help of rollers such that large vehicles could be accommodated as well. Also the projections on the surface of platform could be modified according to the shape of the spacecraft. This is done with the help of infra-red and proximity sensors, which would cause the metal components (from which the platform is made) to shift their position and create a complementary shape to that of the space vehicle.



Docking Ports:-
There are a total of 8 docks, 4 at one end of the central axis and four at the other.
Each dock opens up to 3 doors.

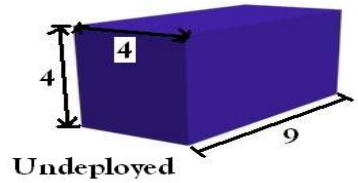
1. Passenger Terminal: The space vehicle carrying passengers, lands and a pressurized duct coming from the passenger terminals is attached to the door of the space vehicle. The passengers travel safely through this duct and at the end of the terminal reach 4 elevator shafts in the central axis through which they can be transported.
2. Cargo Handling Terminal: Robots entering from this door load and unload cargo ships. The material transport to and fro the dock is done by 2 shaft elevators in the central axis, which the cargo-handling terminal leads to.
3. Refueling Terminal: The refueling process is automated. Fuel lines are connected to the space ship. Once refueling is done the ship leaves. When a ship comes for maintenance, dock is closed by an

external shutter. After that the repair process begins which again is fully automated. Once its done, the dock opens again and continues its routinely jobs.

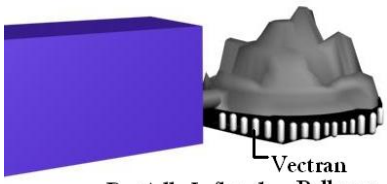
- Before any of these terminals opens, however, electro-static dust precipitators are first activated. For greater efficiency, two dust precipitators are installed in each dock.
- Just below the docking ports, storage and warehousing has been provided for.
- Revenue is generated by charging for cargo-handling, refueling ships, flight fee of the passengers.

2.5 Pre-Fabricated Base:-

The pre-fabricated base on mars, MarsHab, would be an inflatable structure that can be carried inside a 9*9*4 container. The inflatable living space will be made of lightweight, flexible materials stronger than steel. The structure could be folded during transportation in the container and inflated to its original size when deployed in space. Like a balloon, the inflated space will be much larger in size than its collapsed size. It has a 10:1 ratio of packaged vol. to material vol. (meaning that for every cubic centimeter of material there are 9 cm^3 of empty space in the package).

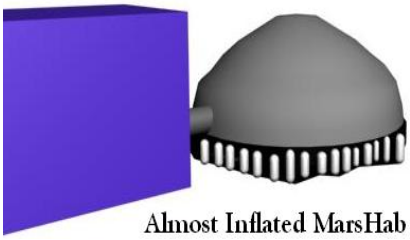


Undeployed

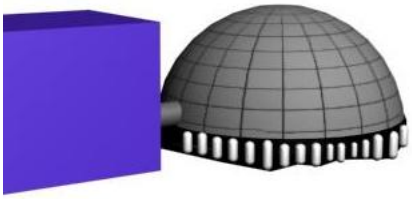


Partially Inflated MarsHab

Taking all aspects under considerations, we choose to have the "hangar design" or a hemispherical design. The biggest stress on the design will come from internal pressure acting outward, and not from gravity acting downward. This is where the arch of the hangar becomes essential, there are no corners, and therefore no weak spots can degrade integrity.


Almost Inflated MarsHab

The materials selected for making the inflatable structure are: Kevlar, Nomex, Nextel, Polyurethane, Carbon fibers and Fiber-Glass. Kevlar has a very high strength to weight ratio; when inflated, it forms a system that is capable of withstanding up to 4 atmospheres of pressure differential (over 54 psi) between interior and exterior which is needed to simulate the terrestrial atmosphere and atmospheric gas quantities. Layers of Nextel combined with polyurethane foam will protect the habitat from **meteors** or other space debris by absorbing energy and shattering the particle before it causes extensive damage. Glass fiber cloth will make the outermost layer as it resists abrasion by particles and the inner most layers would be that of Nomex, which is a fire-proof cloth. The source of all these materials is the soil from Phobos/Deimos, which is refined to produce organic polymers like Kevlar and Nomex, and silicate compounds like glass fiber and Nextel. The final structure can be covered with Martian regolith of around 20g/cm^2. This would provide sufficient radiation shielding.


Deployed

For deployment, the pressure pumps are activated and the inflatable structure is ejected. The pressure keeps building inside the structure till it's fully inflated. The vectran balloons are also pumped, so that the floor of the MarsHab could be leveled. The inflating systems are computerized. The layering of regolith on the exterior is assigned to the robots and the setting up of labs and activating computer/ life-support systems is be done by humans.

3.0 OPERATIONS & INFRASTRUCTURE

3.0 OPERATIONS AND INFRASTRUCTURE

3.1 CONSTRUCTION MATERIAL SOURCES

Orbital Location

Hall electric propulsion system placed in the central cylinder will be used for rotational propulsion and prevention of orbital decay.

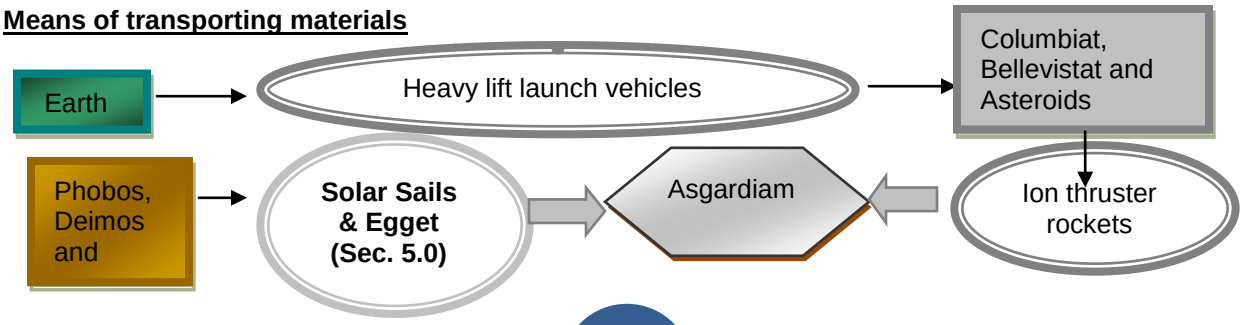
	Details	Reasons for selection
Altitude (km)	17053	- At this altitude, it will be between Phobos and Deimos. - Nearness to Phobos and Deimos will allow easy transport of materials.
Inclination	0 Degrees	- Shuttles between Mars and Asgardiam will be deployed easily and in a shorter time. - Equal and continuous exposure to sunlight of the entire settlement.

Material	Source	Amount (m^3)
Aluminum Silicate	Soil from Phobos and Deimos	21499211
Invar	Refined soil from Phobos and Deimos	12899526.6
RTV Adhesives	Processed soil from Phobos and Deimos	3439873.76
Silicate raw material	Phobos and Deimos	17199368.8
Aluminum Oxynitride	Earth	4299842.2

Materials for settlement operations and their sources	
Material	**Sources**
Water	Earth and polar ice caps on Mars
Oxygen	C-type asteroids, Phobos and Deimos and Earth
Nitrogen	Asteroid volatiles
Platinum	Phobos and Deimos
Iron	Asteroids and Mars
Nickel	Asteroids around Phobos and Deimos
Carbon	Phobos and Deimos, Carbonaceous asteroids
Hydrogen	Water from Phobos and Deimos

Equipment for construction and settlement operations and its sources			
Equipment	**Source**	**Equipment**	**Source**
Refueling unit	Columbiat	Spacesuits	Bellevistat
Dozers	Earth	Antennas	Bellevistat
Ion thruster rockets	Bellevistat	Automated sensors	Earth
Safety tethers	Phobos and Deimos	Computers	Earth
Hall electric propulsion system	Earth	Cranes	Bellevistat
Heavy lift launch vehicles	Bellevistat	Mixers	Bellevistat

Means of transporting materials



3.2 COMMUNITY INFRASTRUCTURE

Atmosphere/ Climate/ Weather Control

- The pressure of atmosphere will be kept at a suitable range less than the Earth in order to reduce atmosphere control cost.

Air Composition				
Gas	**Percentage (%)**	**Pressure(kPa)**	**Pressure(mmHg)**	**Quantity(m^3)**
Oxygen	21	15.7	145.6	52823127.02
Nitrogen	78	26.7	170.0	196200186.1
Carbon Dioxide	0.6	>0.4	3.00.0	1509232.201
Water Vapor	0.3-0.4	1.0 +/- 0.33	7.50 +/- 2.5	~1006154.8
Total	**100**	**43.8**	**326.1**	251538700.1

Atmosphere and Weather Control	
Name	**Control Mechanism**
Oxygen	Apart from the production of plants during photosynthesis, it will also be obtained from C-type asteroids, and asteroidal ores that contain metal oxides using reduction techniques.
Nitrogen	Nitrogen will initially be extracted from asteroid volatiles containing nitrogen gas. It will also be obtained from the breaking down of body waste.
Carbon Dioxide	The excess CO_2 in the air is removed using the system CO_2-ASRT 5A zeolite over the temperature range 0 ° to 250°C.
Humidity and Temperature	A thermoelectric heat exchanger system would monitor the temperature and air currents for wind whereas humidity sensing control devices and ultrasonic humidifiers will regulate the humidity levels of the settlement.
Artificial Rain and Snowfall	Artificial rain will be provided by the process Cloud Top Seeding. Calcium compounds will be used to stimulate the air mass upwind of the target area to rise and form rain clouds. Then, silver iodide and dry ice will be used to build up large beads of water and make them fall down as raindrops or snow.

Climate Control				
Season	**Period**	**Temperature(ºC)**	**Humidity (%)**	**Wind Speed (km/h)**
Winter	November-February	-2-11	55-75	14
Spring	March-May	12-22	60-85	16
Summer	June-August	23-35	50-85	11
Autumn	September-October	9-18	60-80	9

Food Production

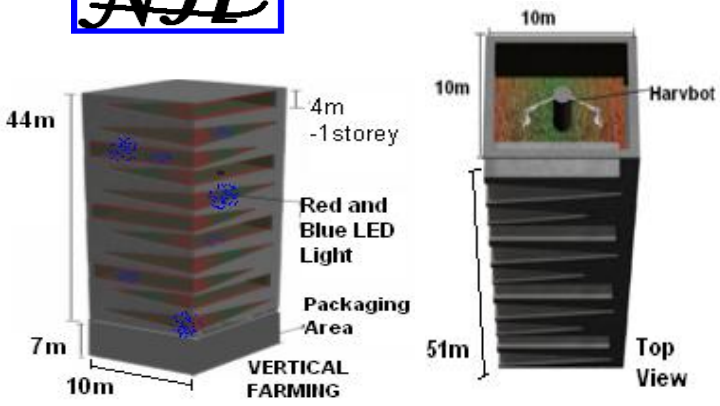
Growing: Crops will be grown in 400 vertical stacks capable of producing 753,430 kg of crops per month, meeting the requirements at Asgardiam; by the method of aeroponics. Vertical farming is done as it uses less space. The plants will be given red-blue LED lighting and there roots will be continuously sprayed with misted nutrient solution.

→

Harvesting: The Harvbot will harvest the crops automatically with its specialized blades.

→

Packaging: Food will first be irradiated and then packed in modified atmosphere packaging which would improve its shelf life. It will then be labeled and stored in storage bays on the agricultural sector in refrigerated sections.



Delivering and Selling: The storage bay will have a direct contact with the Housebot. It will order food using Internet Zero. The delivery vehicle will trace the IP Address and deliver the order to the respective place.

Special in-vitro cultivation stacks will grow meat such as beef, ham and chicken to serve the dietary needs of the population. This ensures a natural, balanced diet for the residents.

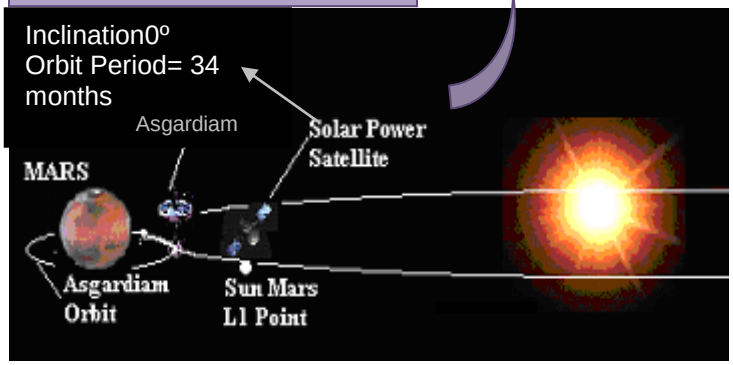
- 1,130,000 kg of extra food commodities and necessities of everyday life will be needed. This will be kept in modified atmosphere packing and stored in huge freezing compartments present in the central cylinder of the settlement in order to combat food supply interruption. This would immensely prolong the life of the stored food without causing any harm to its nutritional value.

Electrical Power Generation

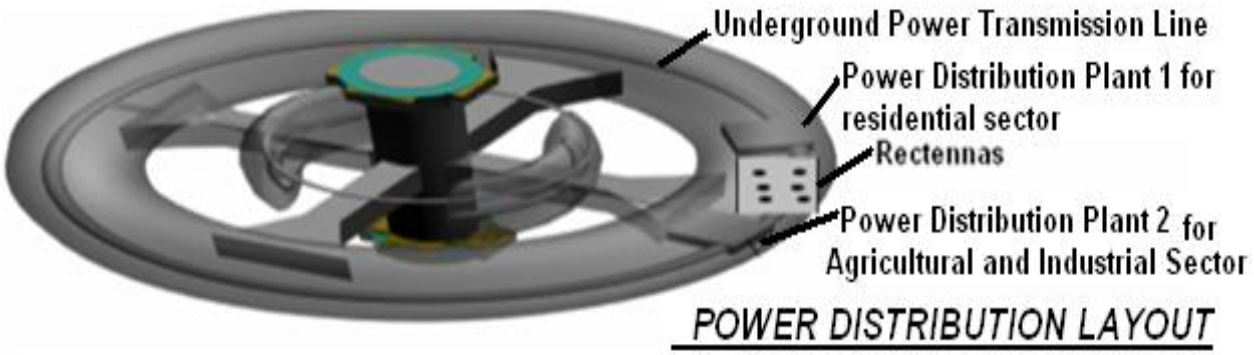
Electrical Energy on the settlement will primarily be obtained by solar power satellites. Solar-generated DC power would be converted to microwaves and transmitted through space as electronically steerable

Power Distribution: These beams would be captured by rectennas in the residential torus and converted back into DC power for underground distribution.

Alternatives: Electricity stored in Ni/H batteries produced by dynamo bicycles. Street lights will be powered by piezoelectricity.



Power Allocation		
Sector	Power (kW)	**%**
Industrial	1832.0	**40**
Residential	1511.4	**33**
Commercial	778.60	**17**
Agricultural	458.00	**10**
Total Requirement	4580.0	100



POWER DISTRIBUTION LAYOUT

Water Management

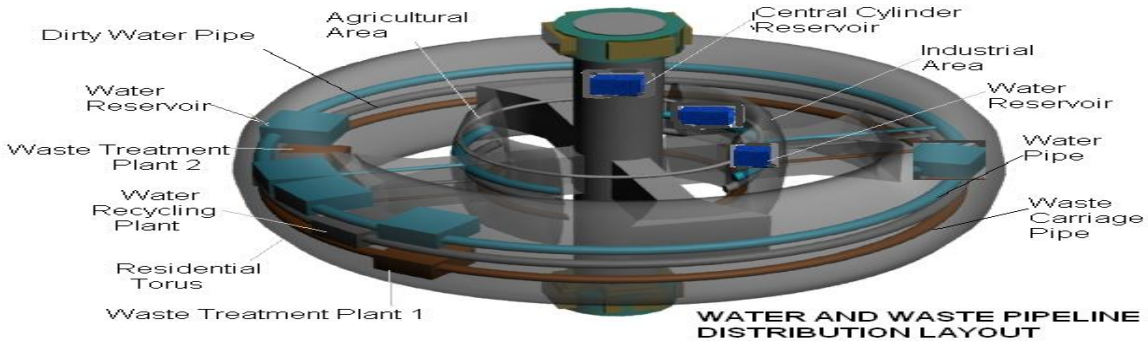
Waste water will first be distilled and then completely purified by ion-exchange and UV exposure.

Storage Facilities:
Pure water will be transported through underground inter-connected pipes to water reservoirs for storage. There will be five main water reservoirs in the residential area, two in the agricultural area and two in the central cylinder for use in the industrial sector.

Water will be supplied from the reservoirs through a system of standing pipes. A central stream will also flow across the settlement.

Required Water Quantity:

Sector	Quantity Required (liters/ day)
Domestic	840,500
Industrial	420,000
Agricultural	250,000
Other (including losses)	6,300
Total	***1,138,800***



WATER AND WASTE PIPELINE DISTRIBUTION LAYOUT

Household and Industrial Solid Waste Management

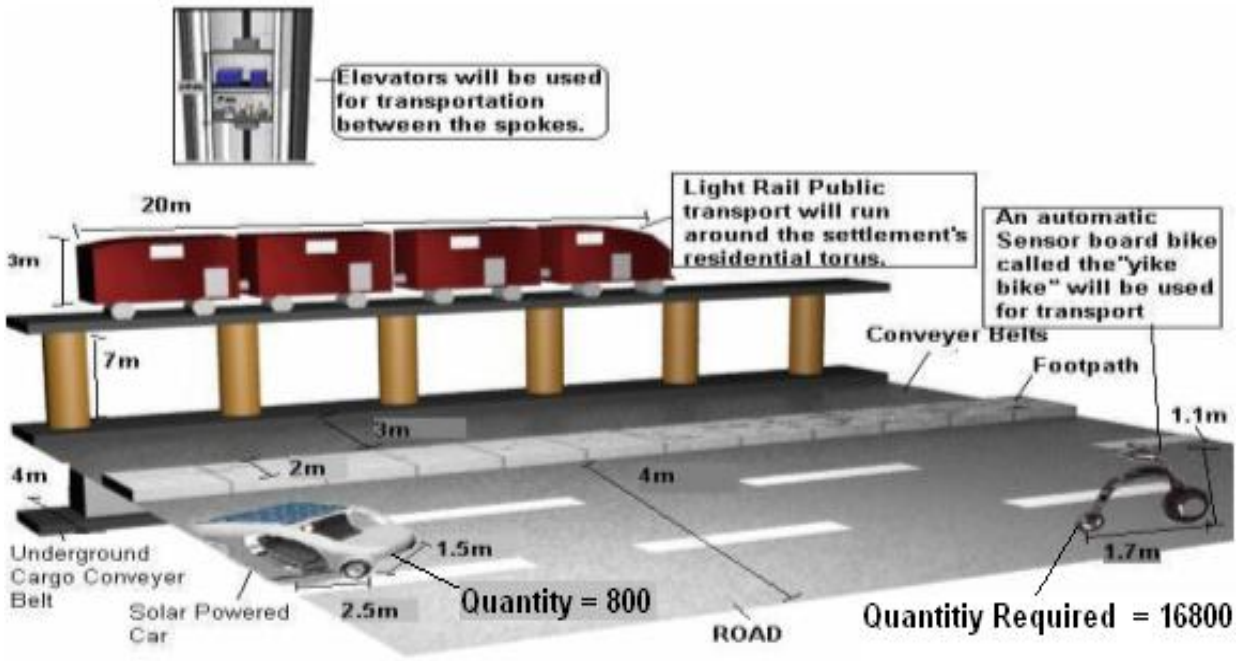
Type	Recycling and Disposal Methods	Quantities
Household waste	Most of the household waste will be gasified by PYTEC system. This will produce five times more energy than what is used.	Waste Gasification Plants = 2
	Some of the organic waste will be recycled inside a thermophilic aerobic reactor. The end products will be used as an animal feed and fertilizer ingredient. The nitrogen broken down will be used to maintain atmosphere composition.	Thermophilic Aerobic Reactor = 1
Industrial Waste	Waste-to-energy gasification will be carried out for industrial waste as well. The ash produced will be supplied for industrial purposes.	Waste Gasification Plant = 2
	Some of the plastics and metals will be heated and melted to remodel them. Plastics will be sorted into polymer type automatically before being melted.	Material Melting Machines = 2

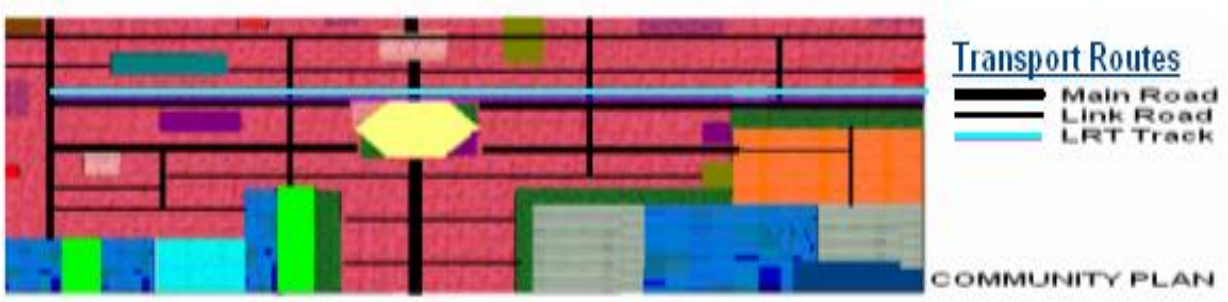
External and Internal Communication

	Technology used	Details	Bandwidth	Devices and Equipment	Quantity
INTERNAL	Photonics	All terminals will be connected using optic fibers, which will be embedded in the floor of the settlement connecting all buildings.	Currently 2.56 Tb/sec	Optical fibres	**Total =3**
				Length= 5852.5m	1
				Length=97 4.9m	2
	WLAN	Entire settlement will be WIMAX enabled. It will have a range of 900m	60 GHz to 6Tb	Routers	10
EXTERNAL	Laser communication	-High data transfer rates -Low probability of interception -Lower power requirements For high bandwidth communication	10Tb/s to 14 Tb/s	Telescopes	2
				Photon detector	1
				Optical fibres	3
	Radio waves(KA-band)	High frequency radio waves: 27GHz to 40GHZ -Will be used as a backup or to communicate with spacecrafts that do not have equipment for laser communication	4Tb/s	Satellites	4

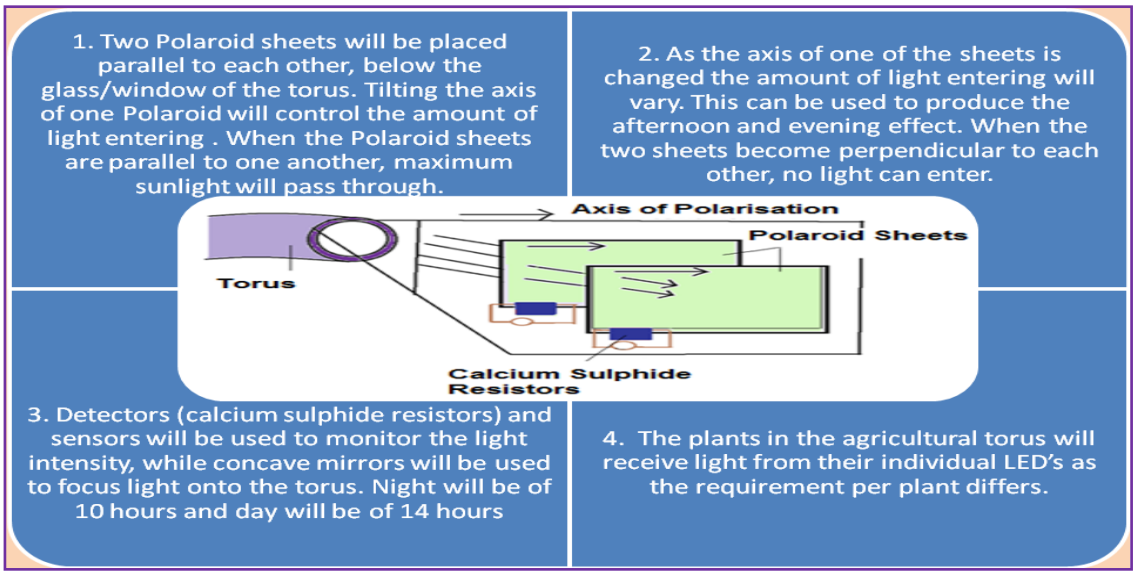
Backup System: One backup satellite will permanently remain in A-orbit (keplarian orbit). The other two satellites will temporarily shift to a B-orbit (non keplarian orbit) during the period of superior conjunction which lasts for not more than 2 weeks and occurs about once every 2 years. All satellites will contain an emergency device. If no communication has taken place between Earth and Asgardiam they will transmit signals which will activate the fourth satellite placed at the Earth Moon Lagrange point and this satellite would then transmit signals to Earth and Asgardiam.

Internal Transportation





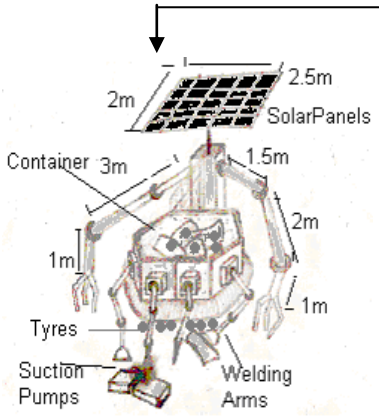
Day and Night Cycle



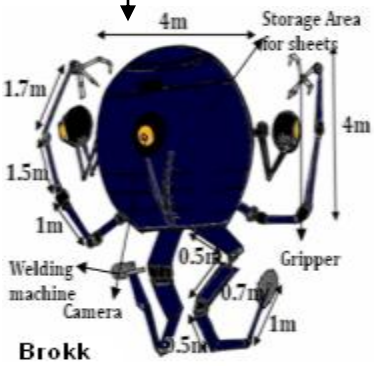
3.3 CONSTRUCTION MACHINERY

- The exterior hull of the settlement will be constructed on the Phobos mining base. GAP and SCAPS sensor will be inserted in the settlement subassemblies which will automatically be brought together by the assembly machines at the settlement location.

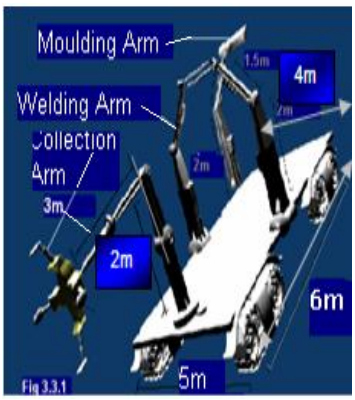
Exterior Hull Construction Machinery



This machine would collect the refined materials (sec 3.1) and weld them into proper shapes.



The fully refined materials will be changed to sheets by this machine.



It will weld and mould sheets to settlement exterior hull sub-assemblies.

Exterior Hull Assembly

Machines & Equipment

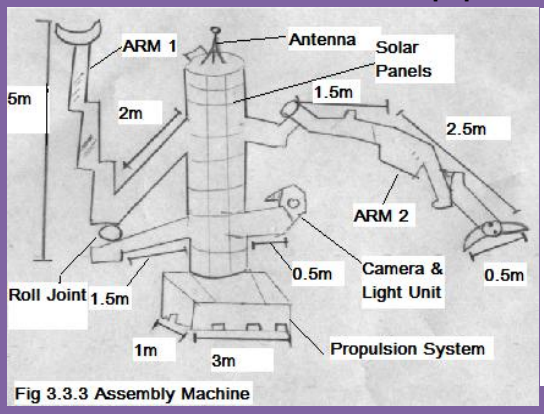
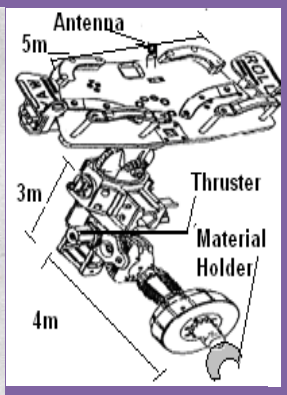


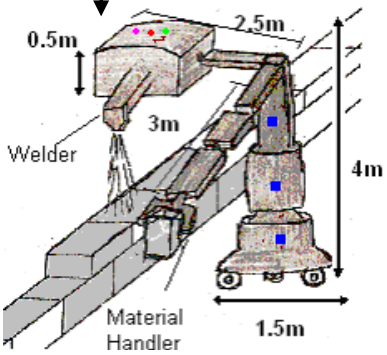
Fig 3.3.3 Assembly Machine



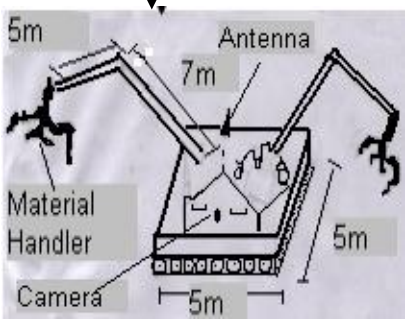
Purpose

- **Once transported to the settlement site, the subassemblies will be brought close enough by Armaplatform (having equipment like material holders and thrusters) and the Assembly Machine so that the assembling sensors get activated and the settlement comes together.**
- **11 machines of both the types will be employed at the Asgardiam location.**

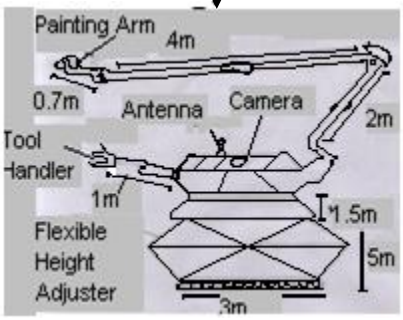
Interior Construction Machinery and Equipment



- This machine will weld and put the materials together to form buildings and infrastructure in the settlement.

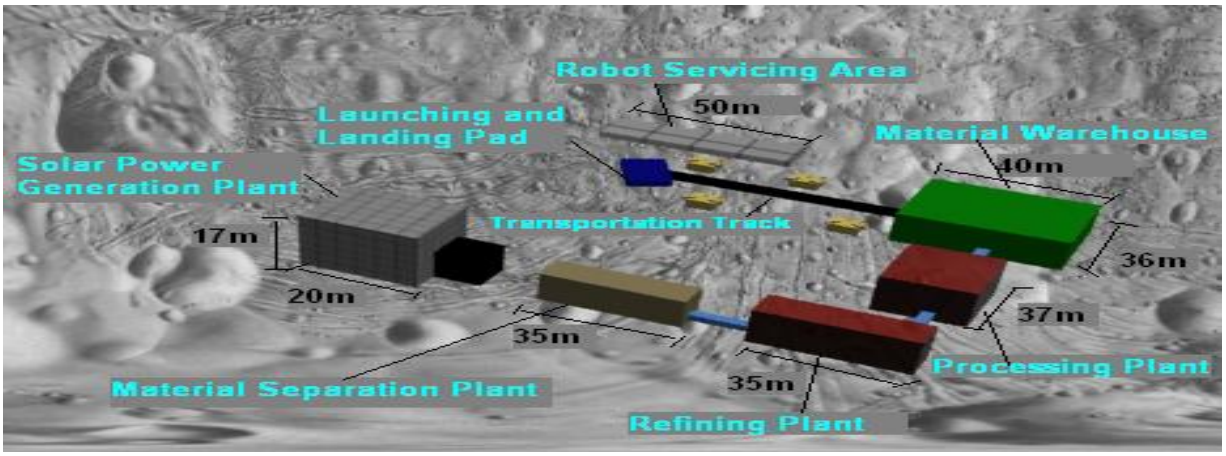


- Large building materials- (refer to section 3.1) will be transported to high altitudes by the Handling equipment.



- The Springer will paint the buildings and give them a final finished form.

Mining Base:



- Phobos and Deimos both will have a mining base. The mining base at Phobos will have an area of 500 m² whereas the Deimos mining base will have an area of 350 m².

Harvesting Operations

The minobot will be used for the excavation of minerals from the moons' base. As shown in 5.5, first drilling will be done by the diamond and laser drills. The mineral containing soil will be shoved and stocked up in the storage compartment of the robot. The Minobot will then travel to the material separation plant. The materials will be internally channelized to the *refining* and *processing plants* for further processing.
The material transportation robots will transport the final products from the warehouse to the launching pad so that they can be taken back to Asgardiam.

Refining and Processing of Resources

- **Magnetic separation of free Metals**: Resources rich in free nickel iron metal granules will be grinded after which they will be put through magnetic fields to separate them from the silicate grains.
- **Separating minerals by Electrostatic Beneficiation**: Electrostatic beneficiation will be used to separate minerals by charging them with static electricity and passing them through an electric field.
- **Separating minerals by Floatation and Vibration**: Sieved mineral grains will be vibrated to separate them into layers based on their weight in a centrifuge. Micro gravity will further aid the process.
- **Electrophoresis:** An electric field will be created across a tank filled with fluid. The mineral grains will be put into the fluid where they will be separated due to micro-g.

Operations of the Prefabricated Base

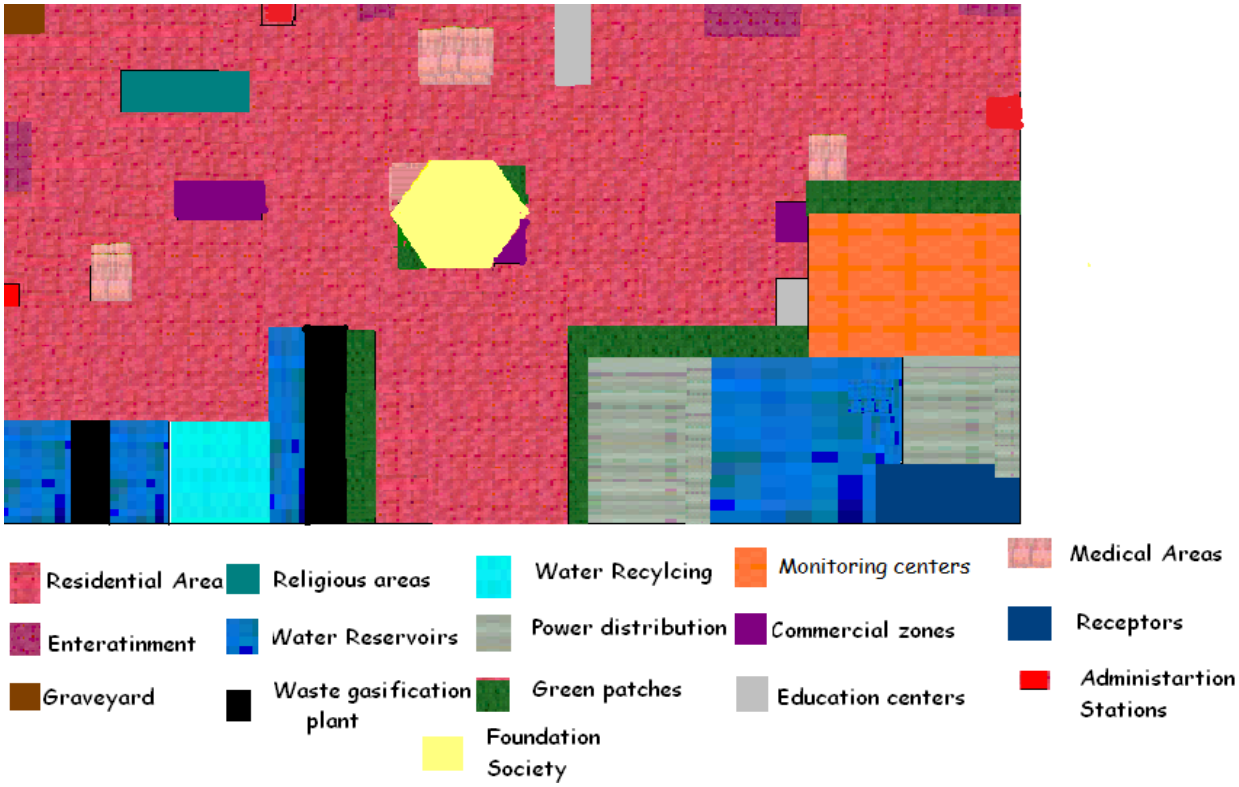
Requirement	Process	Amount
Air	Air will be taken in a pressurized tank and released into the base. Zeolite Oxygen Concentrator will be used to regulate air composition. Carbon dioxide will be removed by lithium hydroxide in replaceable canisters, brought form Asgardiam.	515 m^3
Water	Water will be taken from Asgardiam in containers and will also be produced by recycling urine.	300 litres
Food	Foods packaged in rehydratable containers including soups, casseroles, cereals, eggs, etc. will be taken. Thermostabilized food in aluminum cans and irradiated meats will also be taken along with GM foods. Drinks (coffee, juices) will be packaged as powders.	108 kg
Power	Photovoltaic cells surrounding the base will also be used to generate electricity. NiH batteries will be used to store electricity.	900 kW
Waste	Water Recovery system will be used for providing clean water by reclaiming waste water (including urine, hand wash and showers). The system uses copper grills and activated charcoal filters to first heat the waste water to obtain steam. Passing it through activated charcoal filters purifies it. The products, along with the rest of the waste, are delivered to the water processor for treatment. The impurities are removed through adsorption and ion exchange by a series of multi-filtration beds.	120 kg


4.0 HUMAN FACTORS

4.0 HUMAN FACTORS

4.1- Community Design

4.1.1 Community layout and area allocation



Distance Scale: 3.4 inches = 5852.79m

For area allocation tables, refer to structure section

Percentage allocated to roads and pathways in Torus1: 7 %

Percentage allocated to roads in Torus 2 Segment1 i.e. for Agriculture: 5%

Percentage allocated to roads in Torus 2 Segment1 i.e. for Research: 5%

4.1.2 Housing-Asgardiam will provide residents with 4 different types of houses. These will provide a variety and will satisfy the needs of different economic classes. House keeping has been kept in mind and so housebots (refer to automation) have been designed. Along with that the kitchens are fully automated (refer to automation). These will make the lives of the people more convenient and easy.

4.1.3 Entertainment and Recreation (including parks)-Since entertainment is essential for a healthy mind and body, the contractor has planned extensive activities. All public areas are designed with long line of sights

- A sports complex has been constructed to provide a proper environment and facilities to people who enjoy sports like football, basketball etc.
- Virtual reality games will be introduced in gaming zones using special virtual reality helmets. People will play games without any space constraint and feel as if they have been sucked in the game themselves. Gaming zones will be the hub for hard core gamers providing arrange of other facilities.
- Exploration Land will be constructed having snow parks, mountains and lakes providing activities like fishing, rock climbing boating and skiing.
- For relaxing, there are saloons, spas gyms, fitness centers and yoga classes which will be held on weekly basis.
- A large library will have a variety of books along with a data base providing visual and holographic demonstrations on various subjects.

- A zero-g gaming area will also be constructed offering games like zero-g wrestling, zero-g racing etc.
- The settlement will have a vivid and enjoyable night life with discos and cafes which are open 24/7.
- A virtual zoo will be made where safaris will take place bringing people close to nature.
- Multi screen theatres will be made having 3D and 4D movies.
- Restaurants and cafes will let people enjoy delicacies from all over the world.
- Asgardiam residents will enjoy greenery. Parks and open green spaces have been made so that people can enjoy nature to it fullest.

4.1.4 Medical facilities-For sustaining a healthy life, residents will be provided with regular monthly check up. Their appointments will be appearing on their wrist bands. The settlement consists of small medical centers along with major hospitals. House bots will be equipped with first aid techniques. There will be state of art paramedical service including trained paramedics and ambulances having different sorts of life saving equipment. Medical centers will be linked with the hospitals so that consultation can take place. Non conventional medical facilities such as herbal treatment, acupuncture will also be available for those who want to avail it. Doctor Robot (refer to automation) has been designed with all things required from just a single tooth extraction to major life threatening surgeries.

4.1.5 Education-Quality education will be provided at all levels. Holographic teachers will play a very major role along with the other faculty of the educational centers. These teachers will be teaching on earth but there lectures will be recorded to give it to Asgardiam residents

4.1.6 Miscellaneous facilities-These include the Foundation Society Headquarters where the government and legal system will ensure that the community is heading in the right way. Administration stations such as the fire and police department will function to ensure that the residents of Asgardiam live a safe life. A commercial zone is essential for the development of the community and for it to prosper. Different businesses will be established to build an entrepreneurship within the settlement. Banks and stock exchange market will be in the commercial zone along with shopping malls providing a variety of different shops providing all the consumables and consumer goods needed.

4.1.7 Variety and quantity of consumables

Commodity Group	Quantity per person per year(kg)
Meat	**26.4**
Fish	**9.7**
Chicken	**30**
Milk, eggs and cheese	**117.7**
Bread and Cereals	**83**
Fruits and Vegetables	**135.5**
Oils and Fats	**10.5**
Sauces, spices etc.	**9.1**
Sugar, honey etc.	**30.1**
Total	**452**

Commodity group	Carbohydrates daily(g)	Proteins daily(g)	Fats daily(g)
Meat	0	7	**13**
Fish	0	20	**1.5**
Chicken	0	11.05	**3**
Milk, eggs and cheese	50	7	**15**
Bread and Cereals	200	21	**1**
Fruits and Vegetables	80	25	**5**
Oils and Fats	0	0	**15**
Sauces, spices etc.	20	0.05	**0.5**
Sugar, honey etc.	50	0	**0**
Total	**400**	**91.1**	**54**

4.1.8 Major types of consumer goods, quantities and distribution

Consumer goods	Products	Quantity/per year	Distribution
Food	Refer to above tables	452 kg per person	**The storage bay has a direct contact with the Housebot. It orders food using Internet Zero. The delivery vehicle traces the IP Address and delivers the order to the respective place.**
Medicines	Vaccines, suspensions etc.	2 kg per person	**Chemist stores, pharmacies and hospitals**
Paper	Books, cardboards etc.	250 kg per person	**Departmental stores**
Cosmetics	Skin care products, perfumes etc.	25 pieces per person	**Departmental stores**
Furniture	Desks, sofas etc.	15 pieces per house	**Warehouses and furniture shops**
Kitchen Utensils	Saucepans, ladles etc.	10 pieces per house	**Departmental stores**
Electrical Appliances	Refrigerators, cameras etc.	20 pieces per house	**Departmental stores**
House Accessories	Carpets, curtains etc.	10 pieces per house	**Departmental stores**
Toiletries	Shampoo, soaps etc.	10 kg per person	**Departmental stores**
Clothes/Shoes	Shirts, jeans, joggers etc.	300 meters per person	**Departmental stores**

*Departmental stores, chemist stores, furniture stores and other stores will be located in the commercial zone containing shopping malls.

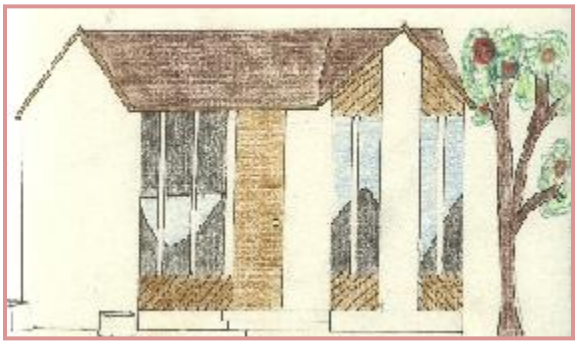
4.2- Residential design

Northdonning Heedwell is required to construct 4 different types of houses. All houses have open living areas so that if needed, screens can be placed to cordon off areas for increased accommodation. Furniture is made of iron as it is easily available at mars surface. It will be polished in different ways to give effect of different textures. It will be made in the industrial section of the settlement. All houses have

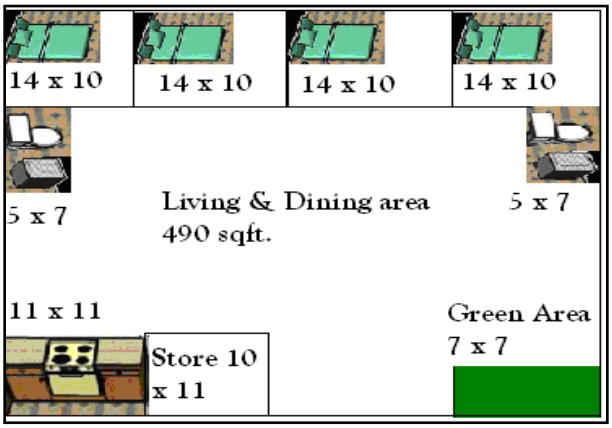
- Green belts in form of lawns or rooftop gardens
- Automatic sliding doors
- Large windows to give a feeling of openness
- Double glazed windows for insulation
- Windows which can change and tint on command eliminating shades and blinds
- Fridges which can track expiration dates of food so that nothing goes waste
- A motion sensitive webcam which sends a picture of person on the door to the wrist watch every person in the settlement wears
- A house robot controlling thermostat, lights, security system etc.
- Folding and compact furniture
- High-definition audio and video systems
- Rooms which are sound proof to ensure privacy

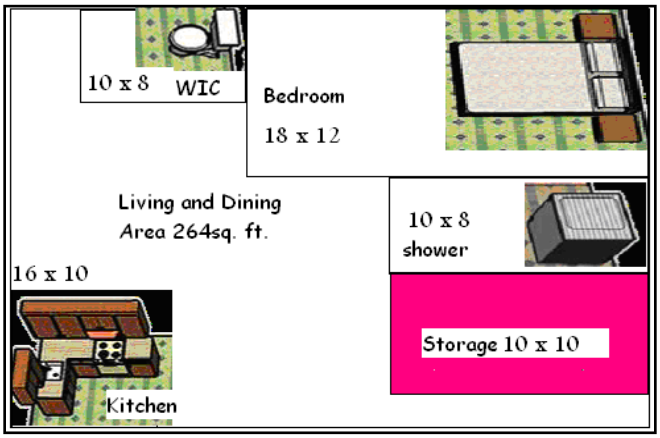
House No.	Area(square feet)	No. of houses
1	1400	1000
2	900	3000
3	1800	510
4	1500	2500

House no. 1- Dormitory for singles (1400 sq. ft.) with a low income

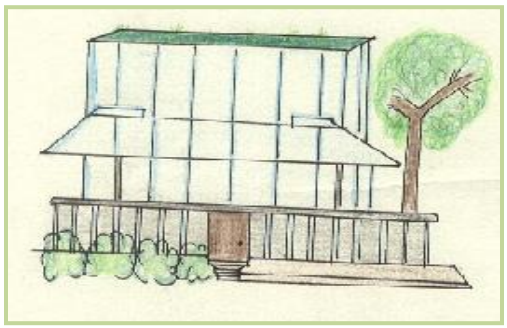


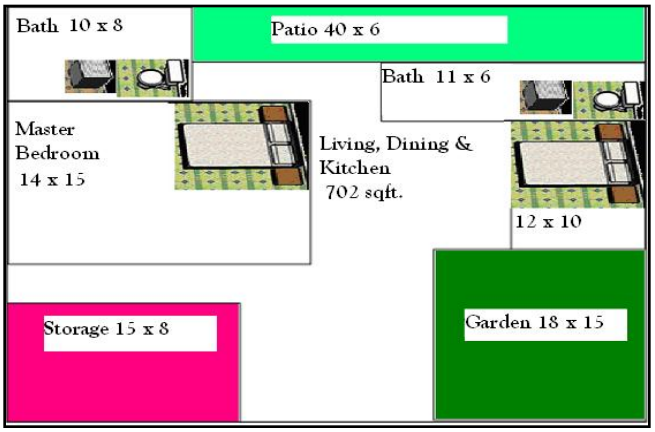
House no. 2- Single bedroom house for singles and couples (900sq. ft.)



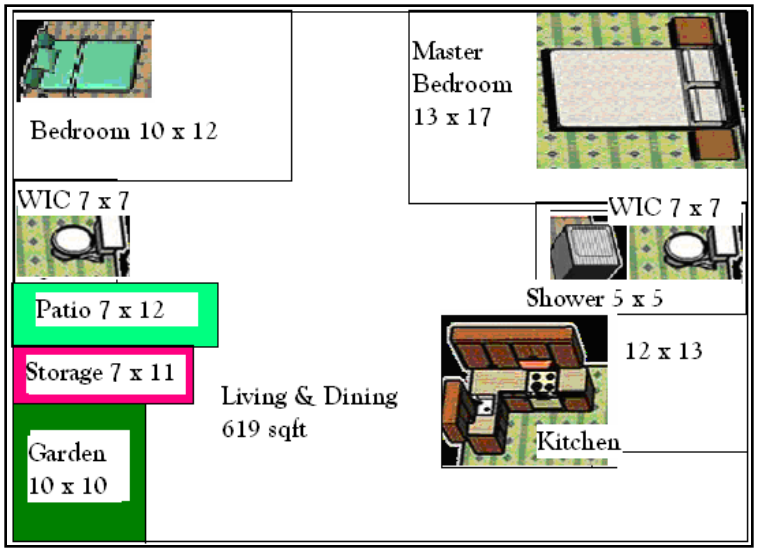


House no.3- 2 bedroom house for couples and families belonging to upper class (1800sq.ft.)





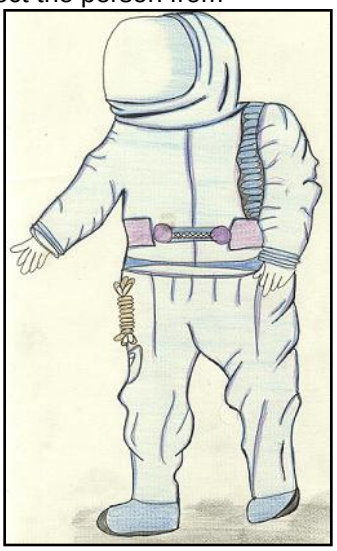
House no. 4- 2bedroom house for upper and middle class couple and families (1500sq. ft.)



4.3 –Safe Access

4.3.1 Space suit design

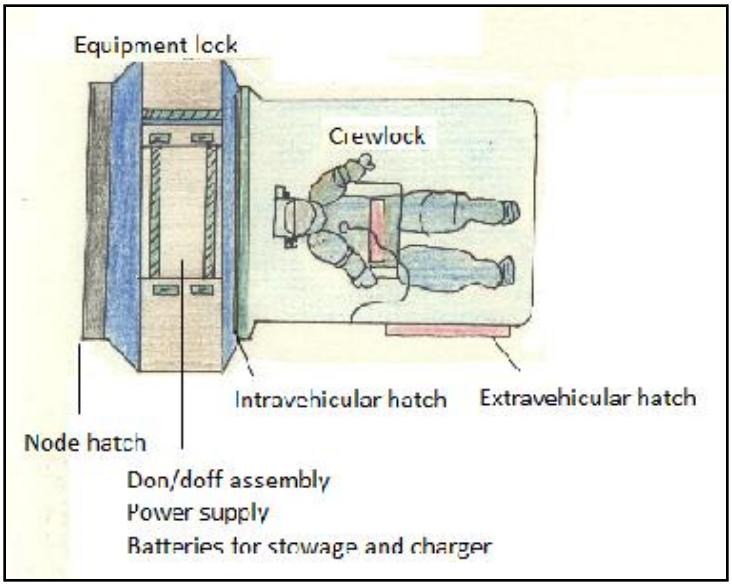
- Pressure suits using heavy elastic body stocking to compress the body
- Liquid cooling and ventilation garment made of nylon tricot and spandex with thin plastic tubes to eliminate excess heat produced
- Thermal micrometeoroid garment (Ortho fabric) layer of clothes to protect the person from micrometeoroid and space dust and radiations.
- Primary and secondary life support system containing oxygen tanks, carbon dioxide scrubbers, cooling water, electrical power, ventilating fans, warning systems and emergency oxygen supply.
- Flexible spiked metal shoes with thermal insulating and electromagnetic boots
- Maximum absorption garment
- Double walled and vacuumed helmet with a purge valve to eliminate carbon dioxide
- Communication Carrier Assembly enabling easy and free communication
- Control belt which automatically removes excess pressure and maintains the temperature
- Maneuverable shoulders, torso, arm, wrist, leg, knee and ankle
- Thin, light, comfortable and easy to work with but will have enhanced strength
- Capable of mimicking muscle fibers



Technical Characteristics

Duration	**8 hours**
Carbon dioxide absorption	10 hours
Pressure	32.4 kPa
Cooling water	4 kg
Power consumed	40W
Oxygen available	1.25kg each
Temperature	25 degrees centigrade

4.3.2 Donning and doffing off procedures-Before donning, the respiratory equipment and clothing is examined. The legs are placed in the garment and the sleeves are put on the shoulders in such a way to ensure that that the suit fits properly and hugs the body completely. Then the thermal micrometeoroid garment is worn after which respirator and face piece are adjusted. The person must be breathing properly. Lastly the boots and gloves are worn



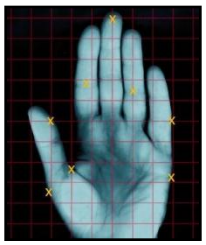
For doffing, the person is firstly disengaged from the extravehicular mobility units. Then all the above steps are repeated in the opposite way

4.3.3 Airlocks and Suit port-In an airlock, before opening either door, the air pressure between the two doors is gradually equalized with that of the environment beyond the door that is to open. In a suit port, a rear entry spacesuit is attached outside a space craft. A person is to enter the suit form inside the space craft. The suit is closed and sealed along with the spacecraft's hatch. The suit is then unsealed and separated from the spacecraft

4.3.4 Transport safety-Head Restraints, seat belts, air bags, autonomous cruise control

4.3.5 Industrial safety-Safety Shutdown system, Fire and gas system, Emergency shutdown, Emergency depressurization, Pressure safety valves, Safety instrumented system

4.3.6 Home/ Business safety-Smoke, heat or CO detector, Passive infrared detector, Vibration or inertia sensors, CCTV, Micro phonic based systems, Access control and bypass codes, Biometric system

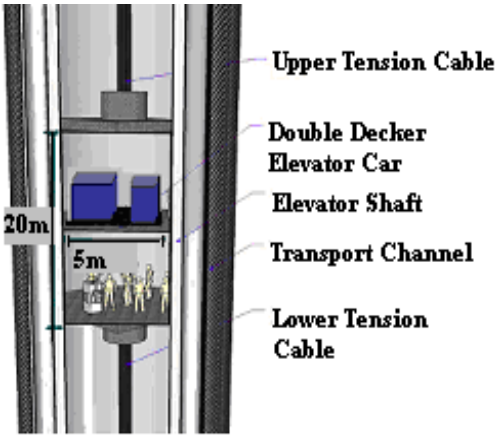


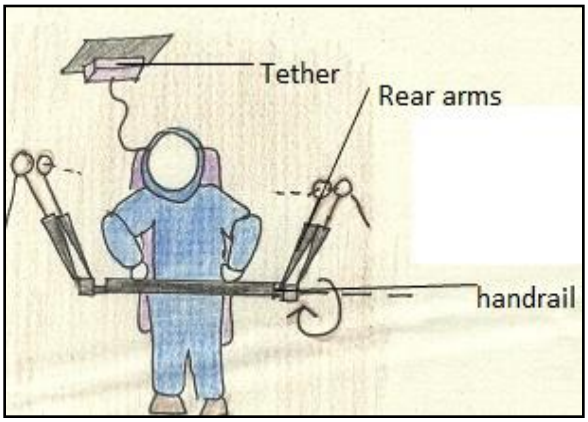
***acknowledged (appendix B)**

4.3.7 Physiological and Psychological health-Elastic bands worn to compress leg bones and reduce osteopenia**,** muscle stimulator device to prevent muscle atrophy**,** proper protection from radiation**,** regular exercise**,** artificial gravity, medication to cure sleep disorders, long lines of sight**,** effective communication with relatives on earth**,** earth like environment e.g. Weather,, day and night cycle**,** rehabilitation centers and counseling for treatment of anxiety, depression, psychosis and home sickness

4.3.8 Safety in Zero G-Tethers, handrails, personal alert systems, safety belts.

4.3.9 Vehicles used by humans



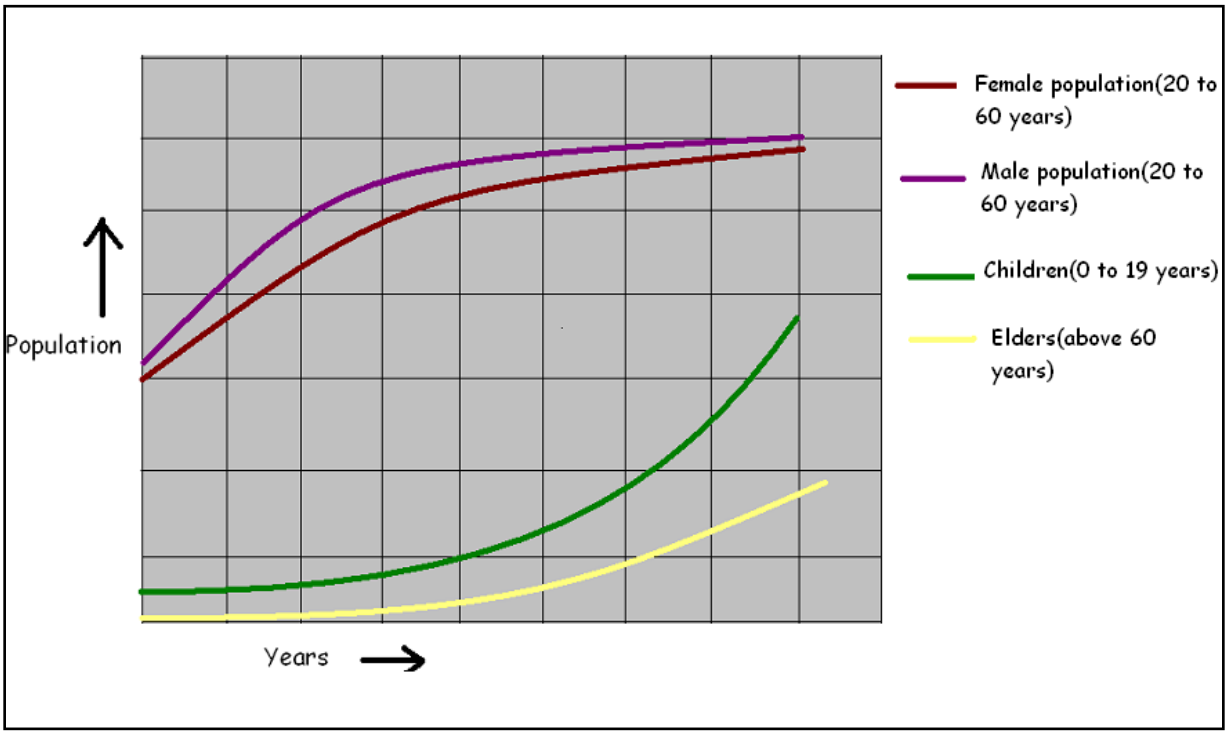


4.4-Demographic Trends

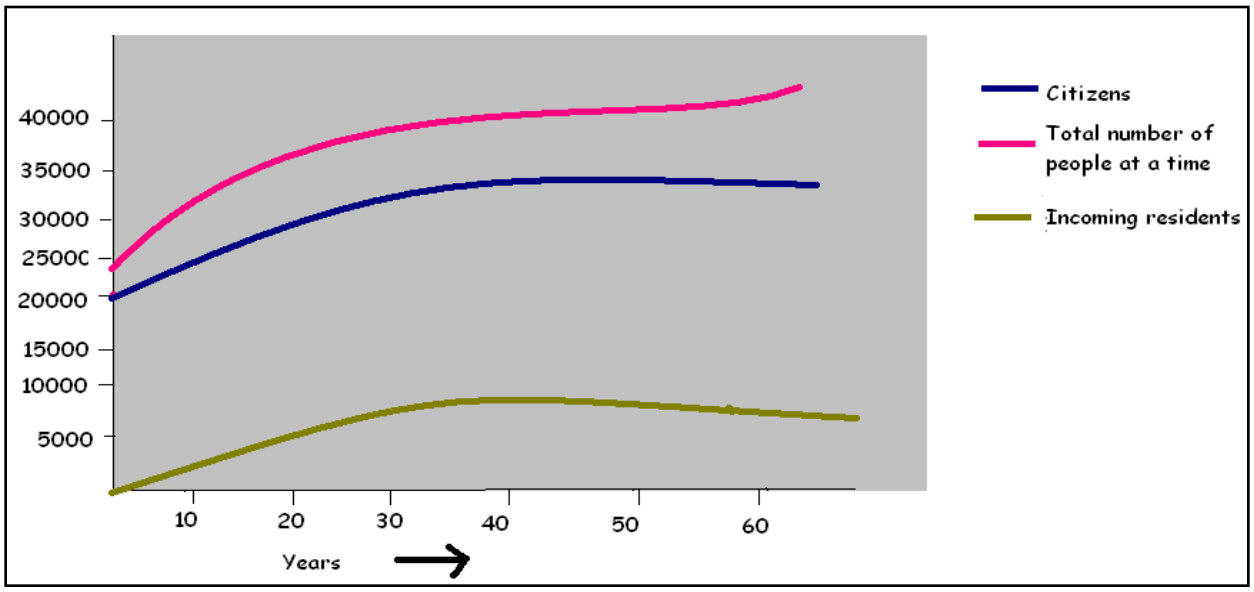
As our settlement is a transient base, we expect a rise in both permanent and transient population. To deal with this, we are taking many steps.

- For expansion in houses, large living areas are provided so that areas can be cordon off with help of screens to make another room. Vertical expansion tie adding one more floor will also take place.
- As amount of children will increase, the contractor will build a mini Disneyland. Holographic historical place will be built for experience and educational purposes etc.
- With the passage of time, the population of children will increase. The area provided for educational institutions is enough to cater for the growing needs and if needed, vertical expansion can take place. However, with the number of toddlers increasing, Asgardiam will aim to provide day care facilities for working parents.
- At present, we have young people in our settlement. As time passes, people will grow old and a need for old homes will arise.

Population Trends with respect to different ages

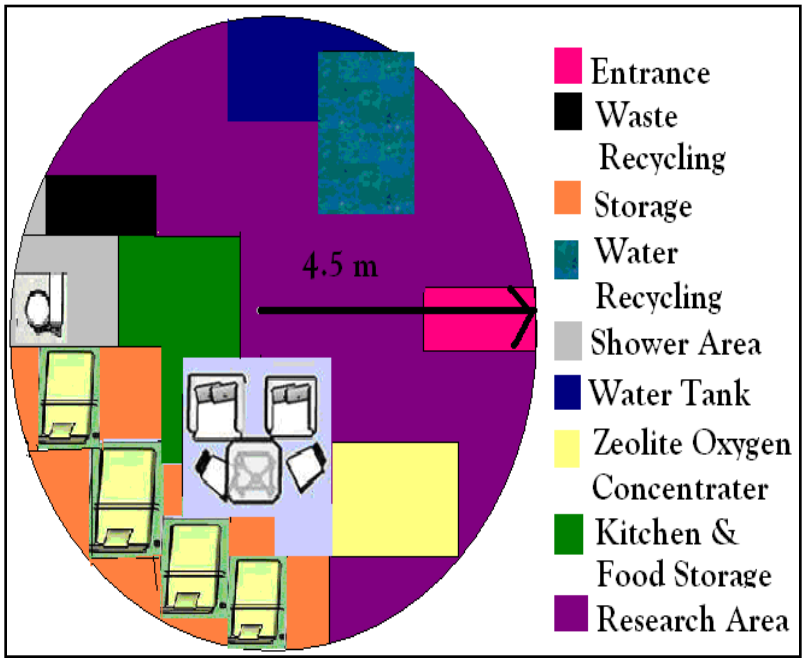


Population Demographic trends with respect to permanent and temporary citizens



4.5- Pre fabricated base

The prefabricated base is ideal for researchers as it will be equipped with all the equipment which is needed. Along with that, it will provide comfortable living conditions as it will be sufficient. It will function as an independent unit for a period of at least 30 days for 4 researchers. Roll up beds and foldable chairs will be used so the base is spacious when these are not being used. The accommodation are consists of 4 beds, toilets and a small living area which have one exercise machine along with television and other things for entertainment. Cupboards are also provided for personal use. These cupboards will also contain spare tools, medical kit and equipment needed for emergencies. An area is reserved for kitchen and food storage area. The area for one bed is 6 feet 2inches into 4 feet 5 inches. The area for the toilet is 3 feet 3inches into 4 feet 6 inches. The entrance will have detectors if any contaminated substances are being brought into the base by the researchers.
Solar Cells are not shown in the interior configuration as they are on top of the base.



5.0 AUTOMATION DESIGN AND SERVICES

5.0 AUTOMATION

5.0.1. Asgardiam will have server virtualization. The physical host sever will be a reconfigurable superfast computer. With an 82 core processor, 38 PFLOPs processing speed, 512 Pb storage and 256 Gb RAM.
There will be 7 guest servers. One for each of the following purposes:

1. Residential management
2. Industrial management
3. Commercial
4. Agriculture
5. Robot control
6. Maintenance and security

5.0.2. Data storage
Data will be stored on holographic hard disks. Back up will be made on parallel running magnetic tapes. An off the settlement backup of Asgardiam's database will be made on one of the satellites in Mars orbit

5.0.3 Number and types of computers

Location	Specifications	Numbers
Homes	Every family member above the age of 8 is given a personal computer in the form of a laptop • 34core processor, 3.2GHz speed, 9Gb Ram,250Gb,	17000
Settlement Terminals	For every 250 square meter Computer Terminals have been placed for basic user functions including e-mail and internet access • 34core processor,2.60GHz speed,6Gb RAM, 160 Gb	8800
Work places	Computers will be provided for all the workers in the offices • 256Gb, 8Gb RAM,34 core processor	11000
M-band (change name)	It Is band worn on the wrist by all residents. It is connected to the personal computer of each user. It making use of six sense technology allowing user to view mail, make internal phone calls, help administration keep a tab on the residents and keep a check on the wearer's health by monitoring heart beat • Quardcore processor, 8Gb storage	17000
Miscellaneous	Computers found in other areas such as shops, parking lots etc. • 512 GB, 8GbRAM,16 core processor	9000

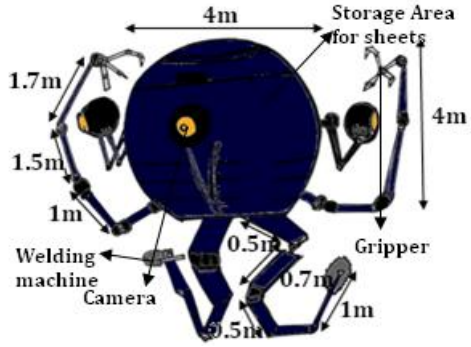
5.0.4 Specifications of networking devices

Network devices	Specification and use
Router	Routs and forwards data
Switch	Connects smaller network segments of Asgardiam to servers and primary routers
Optic fiber cables	Used for telecommunication and internet facilities
Wi-Max	Wireless internet routers

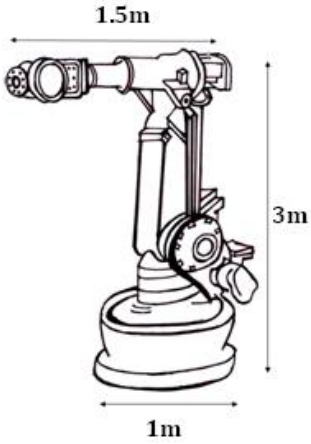
5.1. Automation of Construction Process

5.1.1. Construction

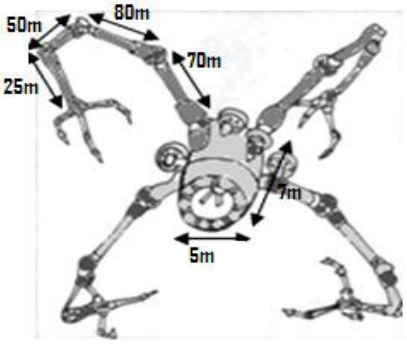
PURPOSE	Name of robot	Location	Numbers
External construction:	1.construction machinery 2. Brokk 3.Davlin	Mining base at Phobos and Deimos	150 15
Assembly of the settlement	Dexo		
Internal construction of houses	Fractal robots	Within the settlement	
Internal construction of other buildings and community centers	Welding machine (3.3)		70
Road construction	Ro-con	Within the settlement	17



Brokk



Dexo



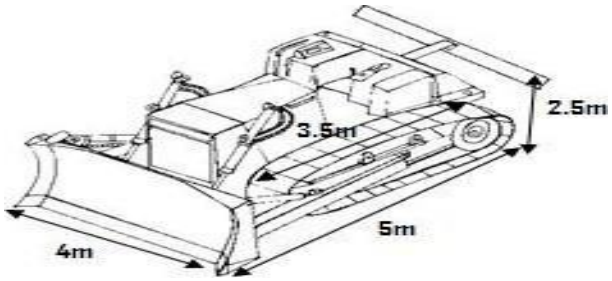
Davlin

Dexo

Large grippers to bring the prefabricated components together
Camera and highly sensitive sensors to determine the accurate position of the various parts
Welding machine to weld the components together
Ion thrusters
Powered by solar panels

FRACTAL ROBOTS

Fractal robots will make used of motorized cubic bricks that move under computer control for the construction of houses. These cubic motorized bricks are programmed to move and shuffle themselves to change shape to make objects potentially in a few seconds because of their motorized internal mechanisms. It uses the technology called Digital Matter Control. This machine has additional electromechanical tools fitted such including glass panels, rolled sheet material, tooling carousel, work parts and pipes. Work parts are shipped to the assembly point and then robot arms or custom tools built into fractal robots perform the final assembly operation. Rolled up sheets of materials can be wrapped around hangar sized structures to make walls and roof. Pipes networks can be laid by the cubes

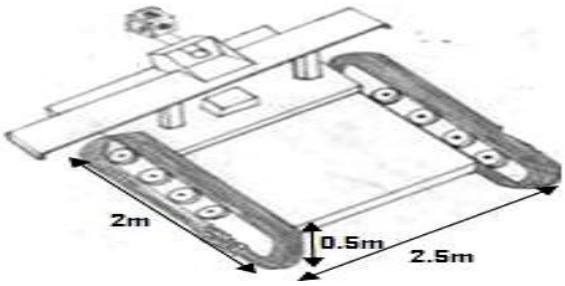


Rocon

It is powered by photovoltaic cells
It has Omni-directional camera for monitoring the surroundings as it constructs the road.
Rollers and precision graders to make the road smooth
Laser scanner for digital terrain mapping (DTM)

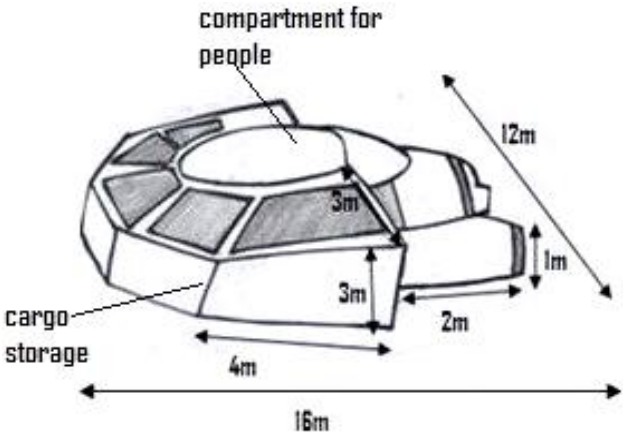
5.1.2 Transportation

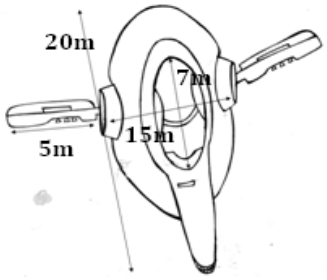
Purpose	Name of robots	Numbers
Transportation (internal) of people	1. Yike bykes 2. Solar cars 3. LRTs	19000 1200
Transportation(internal) of materials, equipment and cargo	1. Arecon 2. Underground conveyer belt	21
Transportation of cargo and people from earth to Asgardiam	Thor 11	107
Transport of sub-assemblies and construction materials to the settlement location	Egget	30



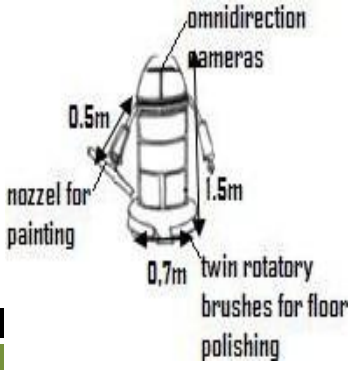
Arecon
Powered by silver zinc batteries
Has a pre stored map of the settlement
Is present in the agricultural area and would be responsible for the transportation of crops to storage area
Load bearing capacity of 2 tons

Thor 11
Uses liquid hydrogen as a fuel
Capacity 60 people and 900 tons of cargo
It will generate revenue by providing transportation between earth and the settlement





Egget



5.1.3. Interior finishing

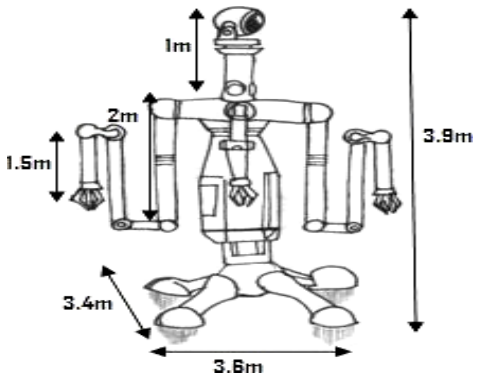
Purpose	Name	Numbers
Interior finishing of the houses	Interno	300
Interior finishing of the settlement	1. Springer	220

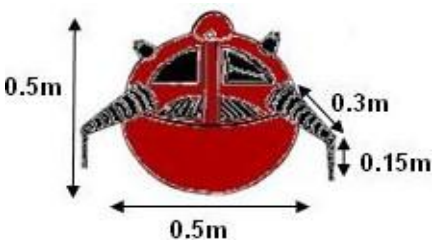
5.2. Facility Automation

5.2.1. Maintenance and repair

Purpose	Names	Numbers
Emergency external repair	Z-kar	60
Safety functions	Artus	280
Maintenance of internal environment	1. A software Cereos 2. Butterfly bot 3. CCD video cameras	420

Z-kar
It has an Omni directional camera
The torso contains the control system
The arm is jointed at five places to allow thre3-D movement
The arms have OCTM parallel jaws for grasping tools





Artus
It has a rotatable camera, alcohol detector and retinal scanner
Will use pressurized carbon dioxide to put out fire
Handle public emergency situations
Monitor community centers

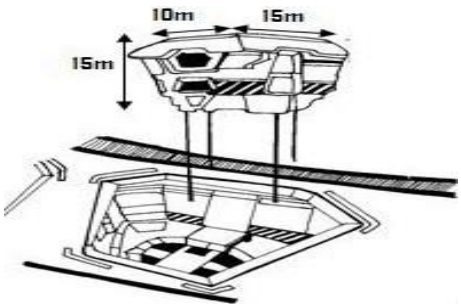
Cereos:
It has pre-stored values. The butterfly-bot keeps it constantly informed of any changes in the composition of the environment. If the values exceed given thresholds then a corrective mechanism is launched
Corrective mechanism includes:

- Trying to bring back values within the given range
- Alerting appropriate officials
- Deploying security bots
- Sealing off a section
- CCD cameras are strategically placed on the walls of the settlement to monitor the settlement at all time

5.2.2. Contingency and back up plans

Risk to the settlement	Contingency plan	Back up plan	Time for action
Solar flare	RXF1, Kevlar regolith and water in the structure protects from solar flares,	External Repair robots are deployed to repair degraded parts of the outermost protection layer	As soon as solar flare occurs
Asteroid and micrometeoroid collisions	A layer of Nextel, Kevlar, carbon Nano tubes	Multiple layers (2 inner pressurized layers) on the exterior which acts as bumper.	
Atmosphere contamination	Cereos tries to keep values back within a given range	Isolation of various sectors until the atmosphere has been decontaminated.	Immediately
Power failure	All energy intensive activities will be ceased immediately. Back energy sources will continue to provide electricity while the problem is rectified.	Robot will fix the damage Energy produced by peizo and dynamic, stored in nickel hydrogen batteries.	Immediately
Fire	Security bot will use pressurized carbon dioxide to put out fire	Incase of a massive fire the compartment will be sealed and air sucked out.	Within 90 seconds
Human violence	Security-bot, the security robot will be deployed against the offender.	A team of up to 6 robots will be dispatched to overcome and arrest the offender.	As soon as the CCD camera detect an offensive act

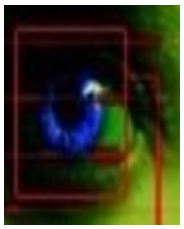
In case of an impending doom when the destruction of the settlement is inevitable escape ships have been embedded in the walls of the settlement.



Escape pod
It has two floors and can seat 50 people at a time.
It has reserves of food and oxygen to support 60 people for a period of three months
It has an autopilot system installed which will take the people to nearest safe settlement.
It has radio communication to contact earth and other settlement.

5.2.3. Authorization

Category	Verification
To gain access to personal computers and personal data	Voice recognition, password and User ID, facial recognition
To gain access to robot resources and use facilities	Facial recognition and retinal scan
To gain access to robot control systems	Vein geometry, retinal scan
To gain access to offices and homes	Access key cards and password, retinal scan, and voice recognition.



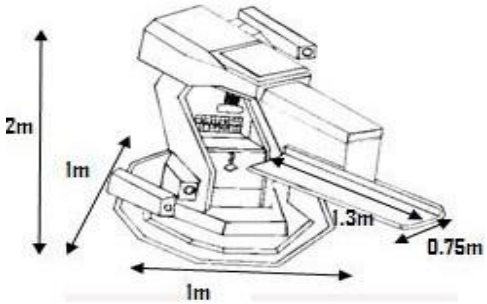

*acknowledged (appendix B)

5.3. Habitability in community

5.3.1. Livability in community

Life in community will be highly efficient and comfortable at Asgardiam. The ease in livability of the residents is ensured by the following ways:

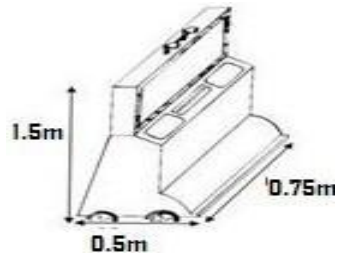
- Security robot as mentioned in the contingency plans would be present to prevent any chaos
- Touch-screen vending machines will be found in shopping malls
- Comfortable transportation vehicles such as LRTs, yike byke and solar cars.
- M-band allows for easy internal communication and entertainment
- Delivery bot automatically delivers necessary groceries to homes
- Doctor bot is present to deal with emergency medical situations, and to transfer injured and sick to the hospitals



Doctor Robot
Has three rotatable wheels
Has complete patient monitoring and life support system
It has a pre-fed map of the settlement to enable it to use The shortest route to the accident place
It also has oxygen reserves, a defibrillator

5.3.2. Productivity in work

Purpose	Name	Numbers
Help manage the day to day activity of offices	1.office bot 2. all work stations will have mind mapping software allow for the workers to organize their thought process 3. all work stations will have the facility of tweeting by thinking enabling the workers to type documents y thinking	520



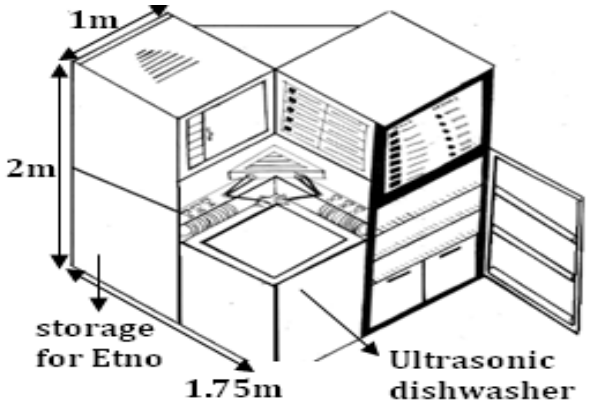
Office bot
It has a voice recognition system enabling it to recognize all the workers.
It has cameras and motion detectors for navigating its way around
It has all office tools including scanner, printer, and holographic projector
It has drink machine for coffee, tea and milkshakes
It has a vacuum cleaner and temporary storage space for garbage

5.3.3. Convenience in residence

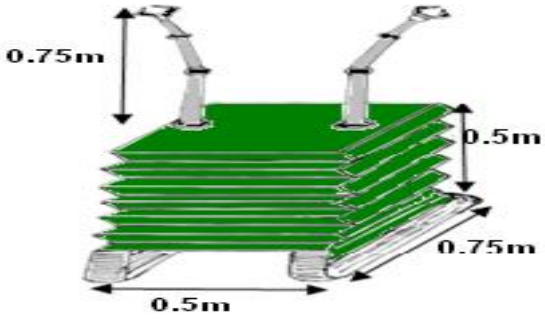
Grotti, an automated system, controls the entire house. An area of internet-zero is created. Each object has its own IP address and is connected to all others and are under the control of Grotti. Rate of speed

is a megabit per second, allowing a large region to be covered preventing interfaces between pieces of the network. The kitchen is fully automated. It has rotatable arms for putting food in the oven and plates on the rack Food items that are running low are automatically reordered. Grotti also controls a robot, etno. Grotti detects dust, stains, spills and things that are out of place and send signals to Etno. Etno can alter its height and is used for cleaning, serving and has hands to pick up clothes and other articles

Automated kitchen

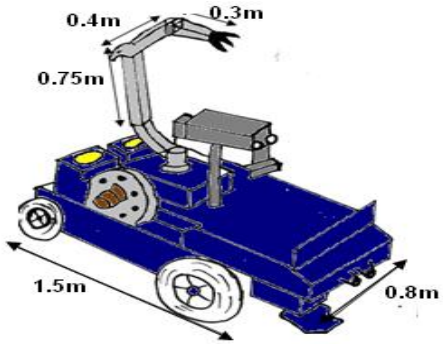


Etno



5.3.4. Maintenance and routine tasks

Purpose	Name	Numbers
Internal repair of the settlement	Foxy-9	80
Harvesting crops	Harvebot(3.2)	400



Foxy-9
Camera and motion sensors for navigating its way around
Laser and ultrasonic detectors to detect damage
Rotating tool inventory to carry our repair functions
Place for storing extra tools

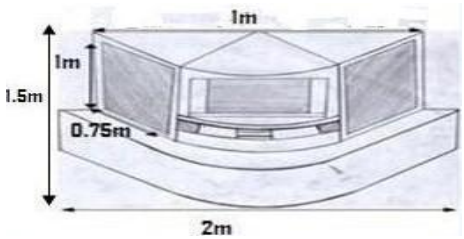
5.3.5. Privacy of personal data:

A password and user ID is assigned to each resident to gain access to their computer and data. Further a biometric facial recognition system authenticates a person's access to a computer system. It makes use of surface texture analysis which takes a skin prints and distinguishes between lines and pores in the skin texture. Since features are not the same for anyone, therefore access will be granted to the owner alone.

Strict laws against hackers will be enforced by the administration to deter people from gaining access into other people's computers. Firewalls and anti-virus software will be installed and regularly updated on all computers.

5.3.6. Devices for

Internal communication	M-band, personal computers, settlement terminals
External communication	Personal computers, settlement terminals
Entertainment	M-band, Recrobot
Obtaining information and computing	Personal computers, settlement terminals
Accessing robot resources	settlement terminals, M-band

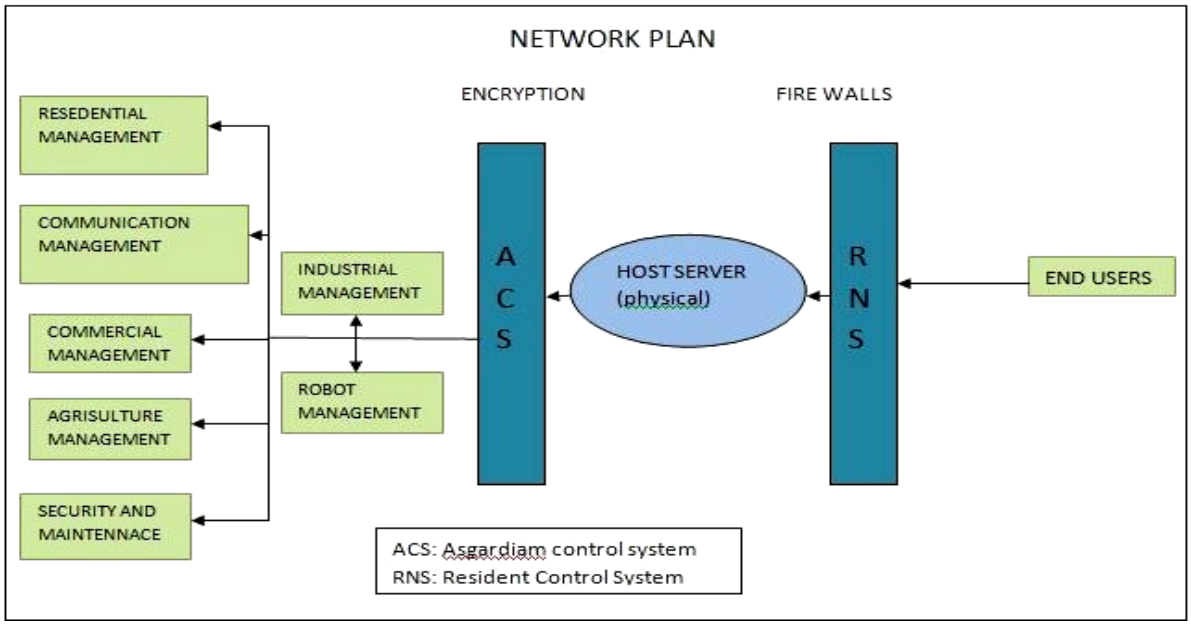


Recrobot

A sofa is installed at the base which can slide out when needed. It uses MMI (mind machine interface) which has sensors to tune into electric signals naturally produced by the brain to detect player thoughts, feelings and expressions. The games can be controlled and influenced by the player's mind. It also has holographic gaming. Gamers will wear special goggles and a head device that tracks the viewpoints of the gamers looking at the screen. On the other end, the people that appear as 3-D images(other gamers)will be tracked with an array of seven ordinary video cameras. It can also show 4-D movies.

5.3.7. Networking

Cloud networking will be used in Asgardiam. The operating system will be centrally installed on the host server. This will be highly space and resource efficient.



5.4 Communication

5.4.1. Appearance of instant access

To give appearance of instant access storage and forward method will be used. A software WR(website retriever) will pick up websites from the earth's internet that are considered relevant and suitable for the residents of Asgardiam. These websites will be stored on a holographic hard disk storage medium. These websites will be updated every day. However news and current affairs will be updated after every 2 hours. When the residents of Asgardiam require certain information it will be obtained from the holographic hard disk in the ISP's server and thus will be instantly available to the user.

5.4.3. User experience

Due to limited speed of light, one way communication delay ranges from 3 to 22 minutes depending upon the position of Mars and its distance from earth. The time lag means telephonic conversations and internet chat is not possible. The residents of Asgardiam will make use of emails, video and holographic messages to communicate with people on earth.

Receiving messages from earth

Sending messages to earth

(*Vixen will be a specially developed software, which will screen through all emails and other messages looking for certain keywords if they are found the message will be withheld and an appropriate officer alerted)

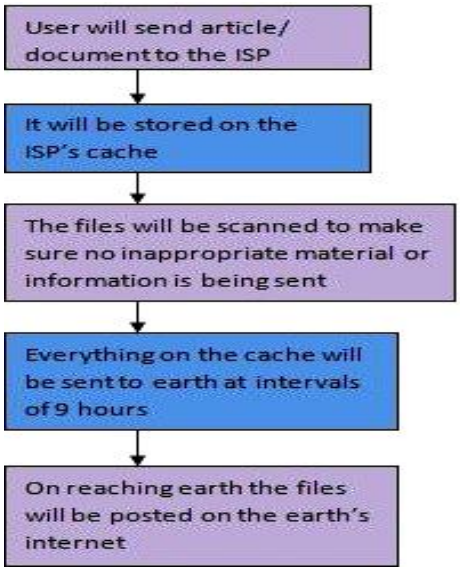
As soon as the resident has sent a video/holographic message/email a pop message will appear on the screen informing the sender of the time it would take for the message to reach the recipient (this time would vary at it would depend upon the distance and position of Mars and Earth)

Sample pop-up message (when sending mail)

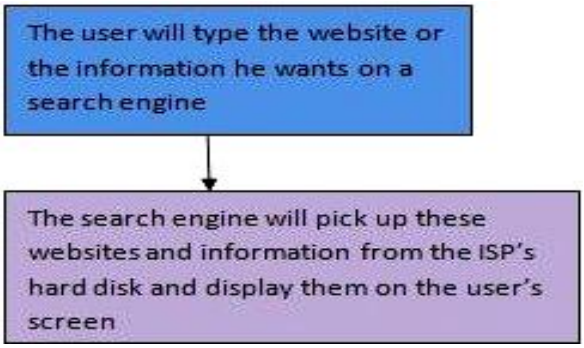
(when receiving mail)

5.4.2. Access process to earth based internet

a) For posting



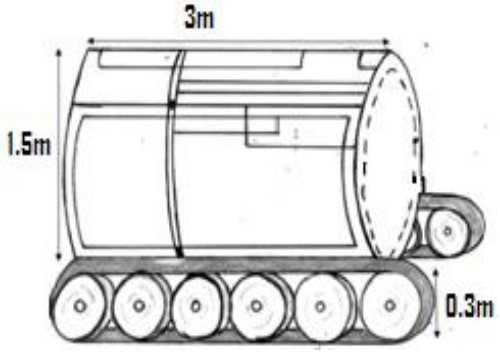
b)for receiving

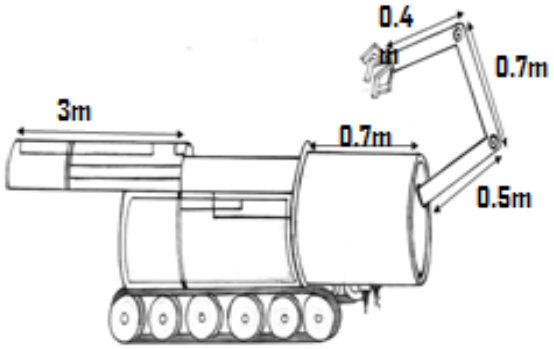


5.5 Automation in Mining and Harvesting

5.5.1. Astro

It has diamond tipped drills and laser drills
It has a mechanical claw for placing mined material in the storage compartment
The refining and processing of mined material will take place in the mining base(3.4)

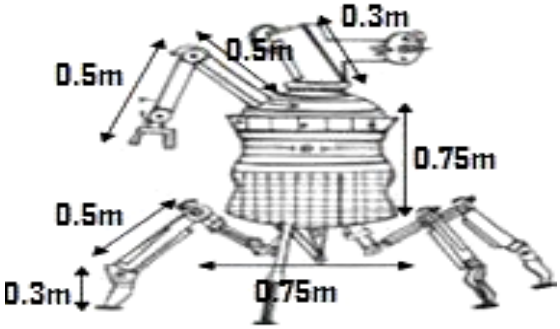




Mining Base: The mining stations will be anchored on to Phobos and Diemos and will be equipped with tools, refining equipment and rescue robots with developed Wi-Max communication systems. These stations will also carry out the primary refining and processing

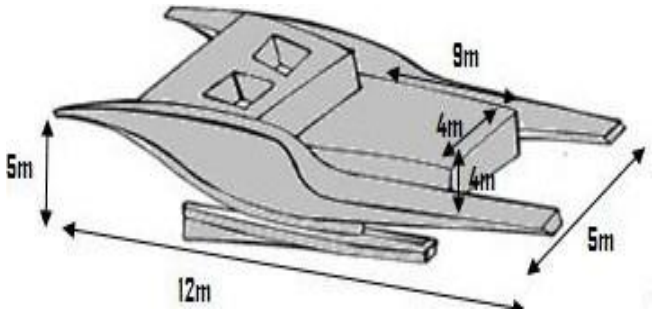
5.5.2 Robotic base deployment

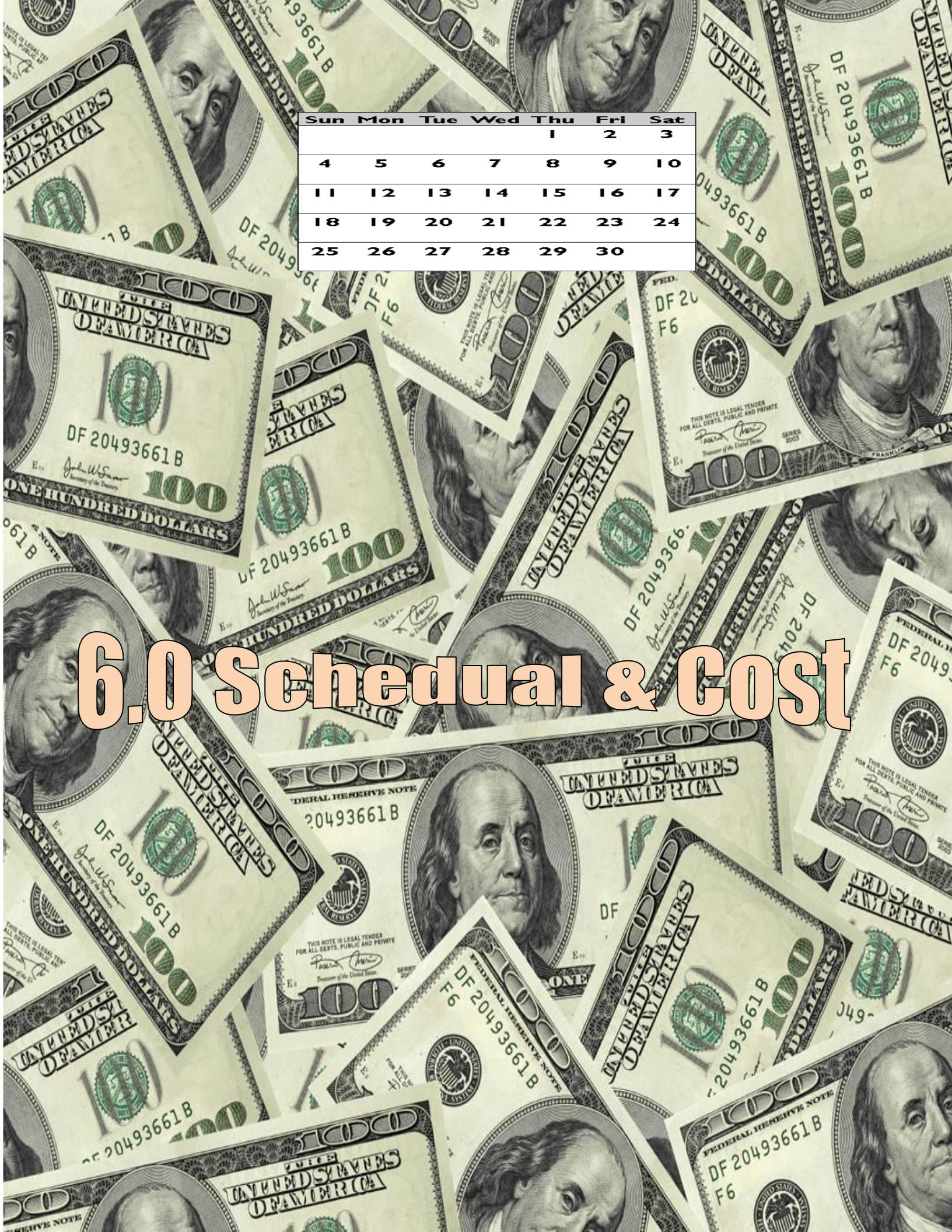
Purpose	Name	Numbers
Provide assistance for deployment of pre-fabricated base	Assistobot	10
Transport pre-fabricated base to Mars	Martian porter	9



Assistobot
Extendable arms and legs
Arms can rotate 360degrees using proprioceptors
It has torque /force sensors
Has tools including pliers, wenches, screw driver and drills

Martian porter
Liquid hydrogen is used as a fuel
Avionics module comprising of electronic systems for use on space crafts, comprising communications, navigation and the display and management of multiple systems
Space and debris protection system





Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

6.0 Schedual & Cost

6.0 SCHEDULE & COST

6.1 Schedule

Every block represents 1 year. Deployment of Asgardiam will take 18 years.

Action	Time period
Research	
Phase 1	**7 May 2055 - 6 May 2059**
Building construction machinery	
Making construction robots	
Transport of crew	
Phase 2	**7 May 2059 - 6 May 2065**
Processing of raw materials for construction	
Building of sub-assemblies of the settlement structure	
Construction of central cylinder	
Construction of two spokes	
Construction of central unit	
Building automation industries for construction	
Construction of the other industries and elevators	
Construction of docking ports	
Building segmented torus	
Phase 3	**7 May 2065 - 6 May 2070**
Building two more spokes	
Construction of outer torus	
Air locks and suit ports	
Setting up of solar power satellites	
Pressurization of the settlement	
Installation of hall electric propulsion system	
Construction of various robots	
Setting up of Polaroid sheets	
Phase 4	**7 May 2070 - 6 May 2073**
Wiring, piping, waste and water plants, communication devices, houses, entertainment	
Emergency systems	
Testing and customization	
Inauguration	

Society members and residents move into their new homes: May 2073 and July 2073 respectively.

6.2 Cost

Phase 1:

Material	Density (kg/m^3)	Volume used per year (m^3)	Mass used per year (kg)	Cost per kg ($)	Cost of material per year ($)
Beta C Titanium	4816.3	2756.25	13274926.88	4.20	55,754,692.9
$BaPbO_3$	2712.63	100	271263	3.20	868,041.6
Iron	7700	90	693000	350	242,550,000
Fuel for transport	510	200	102,000	6.00	612,000

Cost of materials per year = $299,784,734.5. Total cost of materials during Phase 1 = $544,938,859.3.

Work description	Number of employees	Salary per employee per year ($)	Total salary per year ($)	Total salary ($)
Making machinery	45	55,000	2,475,000	4,950,000
Making robots	50	90,000	4,500,000	18,000,000

Total cost of labor during Phase 1 = 22,950,000. **Total cost during Phase 1 = $567,888,859.3.**

Phase 2:

Material	Density (kg/m^3)	Volume used per year (m^3)	Mass used per year (kg)	Cost per kg ($)	Cost per year ($)
Aluminum Silicate	480	2588833.643	1242640149	**16.00**	19,882,242,380
Invar	8055	1553300.186	12511833000	**22.00**	2,752,603,259
RTV Adhesives	1120	414213.3829	463918988.8	**16.80**	7,793,839,012
Silicate raw material	2200	2071066.914	4556347211	**3.20**	14,580,311,080
Aluminum oxynitride	3688	517766.7286	1909523695	**8.00**	15,276,189,560

Cost of materials per year = $60,285,185,290. Total cost of materials during Phase 2 = $301,425,926,500

Work description	Number of employees	Salary per employee per year ($)	Total salary per year ($)	Total salary ($)
Processing of raw materials	45	75,000	3,375,000	20,250,000
Monitoring the construction	15	60,000	900,000	5,400,000

Total cost of labor during Phase 2 = $25,650,000. **Total cost during Phase 2 = $301,451,576,500.**

Phase 3:

Cost of construction materials per year = ~$60,285,185,290 (calculated above). Cost of construction of robots per year = ~$56,622,734.55 (calculated above). Cost of one Polaroid sheet (45 x 50 m^2) = $8.95.

Material/Process	Total Cost ($)
Construction materials	180,855,555,900
Robots	226,490,938
Launch of solar power satellite	110,000,000
Polaroid sheets	28,833.85382
Hall electric propulsion system	9,500,000

Total cost of materials and processes during Phase 3 = $181,201,575,700

Work description	Number of employees	Salary per employee per year ($)	Total salary per year ($)	Total salary ($)
Monitoring the construction	15	60,000	900,000	2,700,000
Construction of robots	70	90,000	6,300,000	25,200,000
Installation of propulsion system	10	45,000	450,000	450,000

Total cost of labor during Phase 3 = $28,350,000. **Total cost during Phase 3 = $181,229,925,700.**

Phase 4:

Cost of 1 router = $40. Cost of optical fibers = $1,855. Cost of photon detector = $16. Cost of 1 telescope = $9.39. Cost of launching 1 satellite = $8,000. Cost of 1 waste management plant = $4,250,000.

Equipment	Total Cost ($)
Water management plant	7,706,033
Waste management plant	8,500,000
Internal communication devices	2,255
External communication devices	37599.78

Total cost of equipment during Phase 4 = $16245887.78.

Material for houses	Density (kg/m^3)	Volume used per year (m^3)	Mass used per year (kg)	Cost per kg ($)	Cost per year ($)
Polycarbonates	1220	610	744200	10	744,200
Epoxy adhesives	550	485	266750	316	84,293,000
Iron	7700	525	4042500	350	1,414,875,000

Cost of housing per year = 1,499,912,200. Total cost of housing = $2,999,824,400.

Work description	Number of employees	Salary per employee per year ($)	Total salary per year ($)	Total salary ($)
Installation of infrastructure	108	42,000	4,536,000	9,072,000
Emergency system	15	30,000	450,000	450,000
Construction of houses	54	29,000	1,566,000	3,132,000

Total cost of labor during Phase 4 = $12,654,000. **Total cost during Phase 4 = 3,028,724,288.**

Contractor fees = $194,911,246 (0.04%).

TOTAL COST BILLED TO THE FOUNDATION SOCIETY = $487,473,026,500


7.0 Business Development

7.0 BUSINESS DEVELOPMENT

7.1 Transportation Node and Port

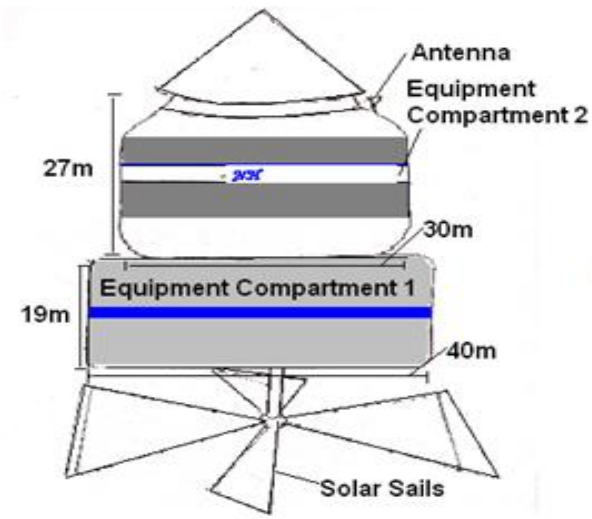
- Docking, warehousing and cargo-handling capability: refer to 2.4
- Terminal facilities: refer to 2.4
- Refueling and provisioning services: refer to 2.4
- Base and repair depot for a fleet of Mars vehicles: refer to 2.4
- Methods for preventing dust from entering enclosed areas in Asgardiam: refer to 2.4
- Medical and quarantine services: refer to 2.1.2

7.2 Manufacturing Centre for elements of Mars and Phobos/Deimos infrastructure

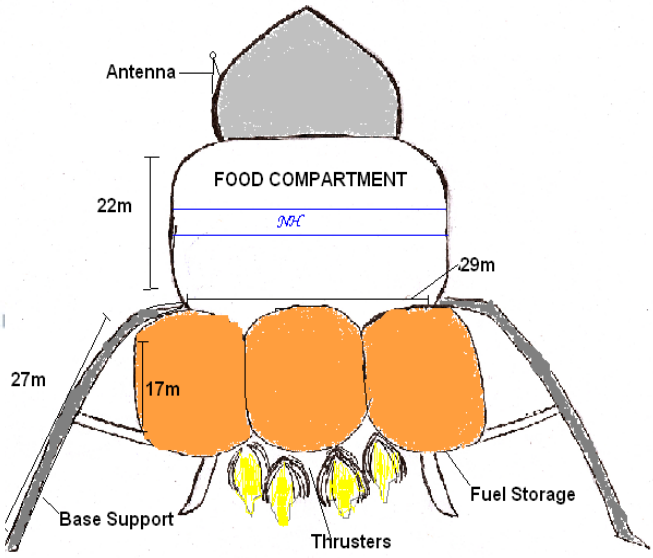
- All the heavy manufacturing of Mars and Phobos/Deimos infrastructure will be carried out in the central cylinder at zero-g.
- The industrial area will be divided into separate sectors for different manufacturing activities. Interested companies will lease these sectors and carry out the manufacturing processes. In this way, revenue will be generated for the settlement.
- The Mars related products will be stored separately and transported to the docking ports through shaft elevators.

Material	Source	Product
Platinum and Aluminum	Phobos and Deimos	Launch/landing and surface vehicles
Hydrogen and Oxygen	Mars	Fuel for vehicles
Copper and Nickel	Asteroids	Tools
Iron and Titanium	Mars and Bellevistat	Machinery
Titanium, Iron and Platinum	Mars, Phobos, Deimos, Bellevistat	Robots
Kevlar, Carbon fibers, Nextel	Phobos and Deimos	Prefabricated transportable bases

The manufacturing processes will be conducted in the non-pressurized central cylinder, in the rotating area. This position for industries has been chosen because it is closer to the docking ports from where all materials will be transferred.



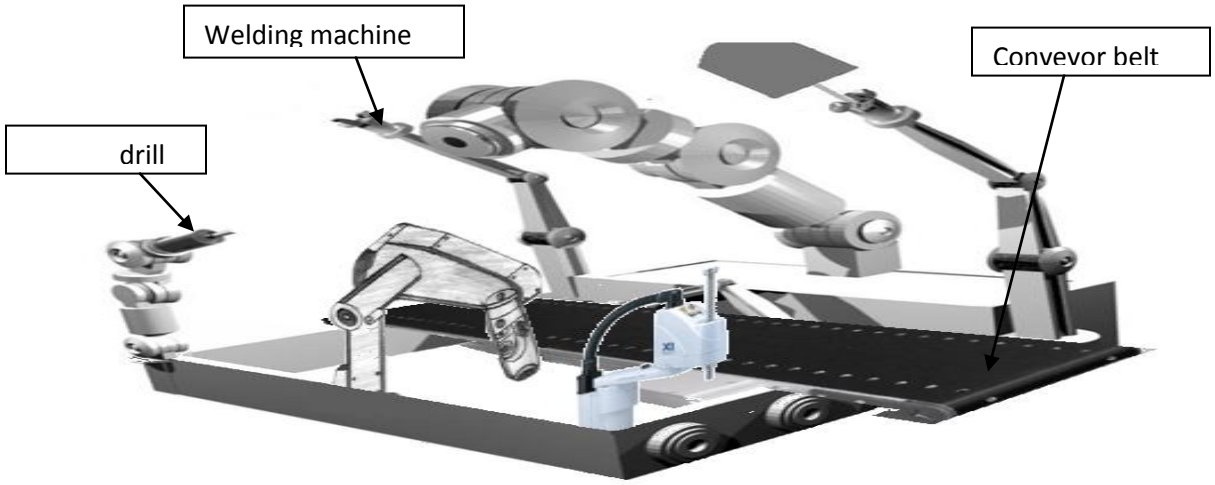
EQUIPSAIL: Equipment & Robot Tranporter



FOODARES: Asgardiam to Mars Food Transporter

- Transport of robots, equipment and food for surface operations: above diagrams

- Representative scene from a production line (robot-production line is capable of producing 30 different robots depending upon the specifications chosen from the pre-fed options present in the central production unit)



7.3 Research centre for development of commercial products from Mars resources

- Research laboratories will be present in one segment of the inner torus at half-g. These will carry out experiments with materials collected on Mars, in order to find out their commercial potential.

- These labs will be equipped with modern research equipment which will identify in detail the various commercial uses of every material.

- After identification, the materials kept in bulk in the storage area will be immediately transported to the industrial area by the robot Arecon. It will transport the materials to the respective industrial sectors so that the production of these commercially viable products is started quickly.

- Only those products will be made whose potential revenue will exceed the additional cost incurred in transporting them from Mars to Earth.

Products	Potential Revenue/Year ($)
Robot components	~ 5 billion
Automobile parts	~ 3.5 billion
Refined minerals	~ 4 billion
More effective pharmaceutical medicines and vaccines	~ 2.5 billion
Equipment like solar sails, solar panels etc.	~ 10 billion
Semiconductor materials	~ 11 – 13 billion
Advanced electronics in plasma physics	~ 7.5 billion

- Quarantine in labs if hazardous materials are identified: refer to 2.1.2


Appendices

APPENDIX A

Structural Engineering:-

Artificial gravity provided for human dwelling is 1g to minimize the difficulty in adjusting to the new environment and also to prevent Coriolis Effect and other psychological disorders. In Agricultural area it has been set at a lower level (i-e 0.49g) because plants can grow and yield better in a low g environment. For research purposes, the g has again been set low, so that some amount of g is there for a few processes while enjoying benefits of micro-g at the same time (such as better crystallization and a better molecular behavior generally). Industrial area and docking ports have been provided with zero-g because there is no/ very little human interference in industrial jobs, all processes being automated. Also, at zero-g, machines work at a better level of efficiency. Parts where there are human and plants are pressurized (residential, agricultural and research areas) because they need atmosphere for their sustenance, whereas the industrial area is non-pressurized, as it is a completely automated area.

Operations Engineering;

Heavy manufacturing in the settlement will be done in the central cylinder because of the ease of transport of raw materials from the docking ports to the industrial area. The storage area for raw materials, in-process products and finished products is also in the central cylinder, so there will be increased efficiency in moving these to and from the manufacturing area. Industries will give out dangerous gases and therefore the industrial area has been kept away from the residential and agricultural area so that there is no difficulty in maintaining air composition. Noise pollution will also be prevented from spreading in the residential area.

Automation Engineering:-

Initially construction robots will be assembled in the residential and agriculture areas in order to provide food for the new arrivals. Further industrial activities such as manufacture of robots, refining and processing of harvested minerals will be carried out in the 0g area industrial area. Firstly the 0g area is closer to the docking port so the need to transport harvested minerals from Phobos and Deimos is greatly reduced. Also as there will be no force acting in 0 g, machines with load bearing capacities of only a few kg will be able to lift tons. Specially modified security bots and internal repair robots will be positioned strategically in the industrial area to deal

Human Engineering:

The central cylinder of Asgardiam has been chosen to carry out the processes associated with heavy manufacturing keeping in mind many factors related to human engineering. The residential area has been kept away from the industrial area so that the residents can lead a peaceful life, away from the turmoil caused by industries. Asgardiam has many green areas and beautiful views for the population; their effectiveness would reduce if there is pollution and

environmental deterioration due to industrial processes. Since the manufacturing processes will mostly be automated, they do not even need to be close to the residential area.

APPENDIX B

- www.nss.org/
- www.wikipedia.org/
- www.spaceelevator.com/
- http://www.encyclopedia.com/doc/1G2-3408800374.html/
- http://www.intel.com/technology/wimax/
- http://searchmobilecomputing.techtarget.com/sDefinition/0,,sid40_gci760820,00.html
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- Space Settlements - A Design Study
- Keys to Space - An Interdisciplinary Approach to Space Studies
- The Case for Mars. Robert Zubrin,
- Asteroids - Their Nature and Utilization
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- Asgardiam (lgs defence phase1 2009)
- www.howstuffworks.com
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- www.issdc.com
- www.spaceset.org
- Automation pictures on pg. 31 from www.biometric.com
- Rockdonnell (ARSSDC semi-finals 2010)
- Human factors pictures on pg. 24 www.flickart.com

APPENDIX-C COMPLIANCE MATRIX

2.0 STRUCTURAL DESIGN		
Requirement	**How Northdonning Heedwell fulfilled it**	**Page No.**
2.1 Exterior Configuration		
Uses of Large enclosed volume	Uses with their justifications	3
Dimensions of major hull components	Calculated and given in table	2,3
Construction materials	Given along with their properties	3,4
Specify volumes of artifical G	Given for each hull component	5
Rationale of rpm and G values	Given for each hull componnet	5
Means of radiation and debris protection	Provides adequate protection	4
Isolate any two of at least 10 separate volumes	Provision of pocket vaults	5
Specify pressurized and non-pressurized areas, rotating and non-rotating areas	Given along with their justifications provided in Appendix A	3
2.2 Internal Arrangement		
Percentage allocation and dimension of down surface area	Percentages given for each torus	6
Drawings to show residential, industrial, commercial, agricultural and other areas	Shown in the construction sequence	7
Orientation of down surface area-map or layout	Illustrated in a map	7
Vertical clearance	Illustrated in a diagram	2

2.3 Construction Technique		
Show at least 6 steps of the construction process and sequence	Shown with their respective descriptions	7,8
Specify when G is provided and method of providing it	Explained in the construction process	8
Construction technique for interior structures making use of materials from Phobos and Deimos	EBF3 and Laminated Object Manufacturing	9
2.4 Expansion		
Design features enabling expansion with reduced initial construction cost and later operation disruptions	Expansion into a banded torus	9, 10
Systems/ interfaces enabling port modification for unknown vehicles	Proximity and infra-red sensors	9
2.5 Pre-fabricated Base		
Dimensions of container (4x4x9)	The inflatable can be carried inside fixed size	9,10
Deployed, undeployed forms of the prefabricated base	Diagramatic illustration	10
Interim configuration	Diagramatic illustration	10

3.0 OPERATIONS & INFRASTRUCTURE		
3.1 Orbital Location and Material Sources		
Mars orbital location: - Altitude - Inclination - Reasons for the selection of both	 - 17053 km - 0 degrees - Given in orbital details table	 11 11 11
Materials for the settlement: - Construction materials and their sources - Operation materials and their sources - Transportation of materials	 - Table provided - Table provided - Launch vehicles, solar sails and ion thruster rockets - Given in construction materials table	 11 11 11 11

- Amounts of materials		
Equipment for the settlement: - Construction equipment and its sources - Operations equipment and its sources	- Table provided - Table provided	11 11
3.2 Community Infrastructure		
Atmosphere of Asgardiam: - Air composition - Pressure of gases - Quantity of gases - Atmosphere and weather control - Climate control	- Table provided - Given in air composition table - Given in air composition table - Table provided - Table provided	12 12 12 12 12
Food production: - Growing - Harvesting - Storing - Packaging - Delivering - Selling - Storage facilities in case of interruption in food production - Quantity of food required	- Aeroponics - Harvbot - Storage bays on agricultural sector - Modified atmosphere packaging - Vehicle using IP address - Internet Zero - Freezing compartments in central cylinder - 753430 kg per month	12 12 12 12 13 13 13 12
Electrical power generation: - Required kilowatts - Distribution of electricity - Allocation for specific uses	- 4,580 kW - Flowchart and diagram provided - Table provided	13 13 13
Water management: - Required quantity of water - Storage facilities	- 1,138,800 litres/day - Water reservoirs shown	14 14
Household and industrial solid waste management: - Method of recycling waste - Method of disposing waste - Quantities of waste handling devices	- Table provided - Table provided - Given in table	14 14 14

Internal communication system: - Devices and central equipment - Quantity of internal communication devices	- Optical fibres and routers - 13	15 15
External communication system: - Devices and central equipment - Quantity of external communication devices	- Telescopes, photon detector, optical fibres, satellites - 10	15 15
Internal transportation system of Asgardiam: - Transportation routes - Vehicles for transport with dimensions - Quantities of internal transport vehicles	- Shown on community plan - Shown on diagram - Labeled on diagram	16 15 15
Day and night cycle: - Schedule of day and night - Mechanism for providing day and night	- 14 hours day and 10 hours night - Polaroid sheets	16 16
3.3 Construction Machinery		
Conceptual designs of machinery used for construction: - Machines for the construction of exterior hull - Machines for the construction of interior buildings - Components and subassemblies delivered to the machines - How they are converted to finished form	- Diagrams provided - Diagrams provided - Mentioned in the description - Mentioned in the description	16 17 16 16
Conceptual designs of equipment used for construction: - Equipment for the	- Diagrams provided	17

	reference to robots	
Educational system	Information about institutions	20
Government and legal system	Description(taken care by the Foundation Society at its headquarters)	20
Variety and quantity of consumer goods	Table	20,21
Major types of consumables and quantities	Table	21
Distribution of food and other consumables	Column in the previous table	21
4.2 Residential Design		
Number and area for different types of houses	Table	22
External and Internal floor designs	Floor plans with room sizes, Drawings for exteriors	22,23
4.3 Safe Access		
Systems and devices for human use	List of major safety systems in different areas of the community	23,24,25
Vehicles used outside artifical gravity	Diagram	25
Space suit design	Description and diagram	23
Donning/ Doffing	Description	24
Airlock designs	Description and diagram	24
Safe human access	4 different means specified including diagrams of tethers and handrails	23
4.4 Demographic Trends		
Demographic trends	Shown in 2 different charts	25
Flexibility of the community	Description telling about means of expansion	25
4.5 Pre-fabricated Base		
Interior Configuration of prefabricated base	Diagram and description	26
5.0 AUTOMATION DESIGN & SERVICES		
No. and types of servers	Server virtualization	27
Data storage devices	Holographic hard disk	27
No. and types of computers	Tables showing various types of computers and their configuration	27

Specifications of network devices	Routers and optic fibers	27
5.1 Automation for Construction processes		
Automation for construction	Davlin and Brokk for exterior construction, fractal robots for interior construction, and dexo for the assembly of settlement	27, 28
Transportation	yike bikes, solar cars, LRTs arecon underground conveyor belt Thor11	28, 29
Interior finishing	Interno springer	29
5.2 Facility Automation		
Maintenance and repair	Z-kar Artus Software cereos, butterfl bot, CCDcameras	29
Contingency and back up plans	Contingency and back up plans show in the table	30
Authorization	Table specifying different methods of accessing systems	30
5.3 Habitability and Community Automation		
Livability in community	Doctor robot and other facilities	31
Productivity in work	Office bot	31
Convenience in residence	Automated house hold systems	31
Maintenance and routine tasks	Foxy-9, Harvebot	32
Privacy of personal data	Passwords, biometric recognition systems, anti-viruses and firewalls	32
Devices for internal communication, external communication, entertainment, obtaining information and computing and accessing robot resources	M-band, personal computers Personal computers, settlement terminals M-band, recrobot Personal computers, settlement terminals M-band, settlement computers	32
Networking	Cloud networking	33
5.4 Communication		

Quarantine if hazardous materials are identified	Provided a large area inside agricultural segment	40